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THE DESIGN OF PUBLIC TRANSPORT MAPS

Graphic elements and design operations in the representation of urban navigation systems

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The [mapmaker] does much more than design in the graphic sense. He/she selects, generalizes, and researches, but in the end he must put his material and determinations into graphic form. It is in this disciplinary aspect that the smallest strides have been done. The ability to gather and reproduce data has far outstripped our ability to present it. (Robinson, 1952)

Motivations

Information design can be defined as the art and science of making complex information and instructions easy to read, understand and use, through visual elements. It is practiced by graphic designers, usability experts, and language simplification specialists.

Information design can dramatically improve people's relationship with public services through user-friendly documents and systems. Effective information design can enhance the efficiency with which these services are run, improve the uptake of services, and help to create a positive relationship between service suppliers and service users (Walker et alt. 2007).

Although Information Design is a relatively new term, the aim to increases civic participation by making the experience clearer, more understandable, easier to accomplish and trust worthier, is not new. William Playfair and his Commercial & Political Atlas (1786), Otto Neurath's Isotype system (1936) and Richard Saul Wurman's "Understanding USA" (2000) are just paradigmatic cases, in which dense information was translated into graphic solutions easier to understand and use. They converted profound governmental research and statistics into a picture narrative and resolved the drama of social interpretation: making complex topics clear.

Government and public services have a responsibility to remove the barriers for participation in civic life. This includes making the tools of participation (i.e. surveys, forms, web sites, informational publications, wayfinding systems) easy for every citizen to use and understand, especially in areas such as Elections, Emergency an Evacuation, Immigration, Travel and Transportation, Universal Design, Medical Information, Wage and Salary Reporting.

Today's Governments and public policies are increasingly faced with more complex and ambiguous issues. Traditionally, organizations and systems have been designed for a complicated rather than a complex world. Although some conventional design solutions still provide suitable answer to the increment of informational variables, in many circumstances they are not effective handling high levels of complexity. For this reason, many long standing institutions are now struggling to adapt to a more complex world (Burns et alt. 2006).

Information design can significantly assist the explanation of complex issues, trends and decisions, therefore today's scenario presents many challenges and opportunities for this discipline (Wurman, 1990).

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Abstract

Public Transport Maps are probably one of the most common forms of graphic communication (Avelar, 2002) and certainly one of the most recognizable cartographic items in the world (Ovenden, 2005). They are present in most developed urban areas and help million of users to navigate through their cities every day. Public Transport Maps have become effective visual tools for communicating spatial concepts and presenting navigation information –such as routes direction, transport modes, stations, connections, landmarks, etc.– through a particular graphic language and design techniques.

Designers' recognition and control over this language and techniques not only affects the visual characteristic of the map and the users interaction with the network, but also their interpretation of the city and other contextual conditions. Perhaps, for these reasons -and despite several attempts from computer science and transport authorities to automatize and normalize their construction- the design of most Public Transport Maps still relays on designers' criteria.

The following thesis presents the main design issues regarding the conceptualization and graphic construction of Public Transport Maps through several case studies. It pretends to identify the different aspects and elements that should be considered in their design and how they are graphically represented.

The first part of this thesis introduces and contextualizes Public Transport Maps as a complex communication artifact through two emblematic cases: London's Underground map and New York's subway diagram. Afterwards, it looks at the main conditions that shape their design, such as the transport system, the user, the context and the mapmaker.

The second part examines the elements, attributes and graphic operations commonly symbolized by mapmakers worldwide, through a comprehensive survey of international cases. It also establishes an analytical framework based on cartographic and typographic principles that may support design processes of Public Transport Maps and further studies on the subject.

The third part presents insights regarding the construction of Public Transport Maps and compiles guidelines and recommendations for those involved in this process.

It finally synthesize above observations reviewing the design process of a Public Transport map recently developed.

This thesis pretends to support mapmakers in their graphic decisions and make a contribution to the current multidisciplinary discussion on the field, from the point of view of a practicing designer.

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Chapter 1
Public Transport Maps

1.1 INTRODUCTION

Public transportation plays a crucial role in providing mobility to general public and ensuring that people have access to the opportunities that exist within their communities (Cain, 2007).

A public transport system should provide equal opportunities for mobility and participation in public life. People should be able to have access to the city as a whole and to choose of whether to use public transport or not. The democratic view of the transportation system offers new participation and competence in the public transport organization, making the system continually useful for all users (Avelar, 2006).

Transport's success in providing mobility depends on people knowing that such services exist and understanding how to use them. While transit marketing focuses on making people aware of available services, transport information systems should focus on providing people with the information they need to effectively use the network.

Good passenger information is an essential ingredient of a successful public transport system: ill informed travelers may not be able to identify services which best suit their needs, leading to poor perceptions and low use of public transport (Balcombe, 2004).

Public Transportation information systems make use of diverse types of information media. This range goes from "traditional" information aids, such as maps, timetables and bus signage, to electronic options like Internet trip planners and real-time information displays. Each information aid has its own strengths and weaknesses, and most transport agencies use a combination to cater to different customer needs and preferences. (Cain, 2007)

Information needs and information media preferences vary tremendously in relation to the type of trip being undertaken and the personal characteristics and experience of each traveler. The following table shows a wide range of different information aids available.

DIFFERENT TYPES OF TRANSIT INFORMATION AID

MEDIA GENRE	MEDIA TYPE	MEDIA STYLE	DESCRIPTION / EXAMPLES
Printed Info. Material			
	Hand-held printed info.	Passive	System maps, route maps, ride guides, schedules /Timetables
	Static printed info.	Passive	Static signage at bus stops, transfer centers and elsewhere
Verbal Instruction			
	Face-to-face communication	Interactive	Receiving instructions from transit staff, other passengers, friends / family
	Manned call center	Interactive	Receiving instruction from transit staff via phone
	Automated call center	Passive/Active/Interactive	Automated instructions via phone
	PA Systems	Active	Verbal messages at station/transfer center, or in-vehicle, via internal PA system
Electronic Information			
	Digital signage	Active	"Real-time" Bus arrival information at bus stops/platform information at stations
	Information kiosks	Passive/Active/Interactive	Information kiosks at stations or bus stops
	Online info materials	Passive/Active	Online schedules / maps, etc
	Internet / PDA trip planners	Interactive	Online trip planners that provide travelers with travel instructions.

Table based in Cain, 2007

Studies on the information needs of public transport users generally consider travel as a dynamic process within which the user has to carry out different tasks (Infopolis 2, 1999). This process consists of a sequence of stages that can be summarized in:

• **Pre-trip** *(prior to the beginning of the trip)*
Essentially refers to the travel-planning context. When the user prepares his future travel, the planning step defines the way in which the tasks must be performed to attain the goals of the journey. Each user has different task criteria by virtue of his personal context and reason for traveling.

The Pre-Trip stage is the most important stage of the transit trip for obtaining essential trip information. Once the trip has been initiated, it appears that information needs are reduced. In this stage, static information is the most important form of information for unfamiliar trips.

• **On-trip** *(during the trip)*
During the on-trip context, the main task for the traveler is tracking (cognitive activity). The tracking task involves verifying that his/her actions and understanding of the information is correct and determining his/her behavior accordingly. It is therefore concerned with the execution of accurate movements at the correct time. Moreover, the disruption / adjustment process requires that the user anticipates future problems from current conditions.

• **End-trip** *(from the last PT vehicle to the final destination).*
The results of the journey concern the end-trip context. The user acquires experience from his journeys, and afterwards he applies his new knowledge to future trips. Thus, through a feed-back loop, the assessment task serves to influence the planning and the tracking task.

According to Infopolis 2, multimodal travelers adapt to the context at each step of the trip. In order to carry out these tasks, the main role of information is to reduce uncertainty during the complete journey. Thus, it is important to provide a coherent and efficient spatial-temporal system according to the different information needs of the user throughout the different stages of the trip.

The rapid development and expansion of electronic media has introduced important improvements in providing information aid to public transportation travelers. However, printed information materials remain the dominant transit trip planning media and the most popular among users (Cain, 2007). Hand-held printed materials are still recognized to be extremely useful in all the traveling stages, especially in pre-trip planning as well as on-trip tracking, and are commonly regarded as essential to trip planning by transit users. A study titled “Customer Preferences for Transit ATIS” found that users still preferred traditional forms of paper-based information (e.g. schedules, maps and fares) (Cluett et al, 2003), instead of other media for public transport information.

Within all the printed material available for providing information to travelers through a transport network, system maps are considered amongst the most essential of all and a priority when there are not other sources of information available (Cain, 2007).

A system map shows the location of all the transit routes within a given area. The system map is designed to give the transit user an overview of the complete system and, eventually, its relationship with the area's geography, built on the cognitive map of the area that the passenger may already have. The primary purpose of a system map is to allow users to locate the origin and destination of their trip, and decide which route, or combination of routes, is best for reaching their destination.

However, previous research (Cain, 2004) has shown that a significant proportion of the general public is still unable to successfully plan a transit trip -particularly on "complex trips" featuring multiple routes and transfers -using this kind of information material. There is evidence that such trip planning difficulties represent a major barrier to transit use among non-users, and may also contribute to the underutilization of transit services by existing users.

Most of the time, the design of system maps has to respond to multiple local conditions such as the network; the context and the users. The diverse nature of all these variables transform the development of these maps into a quite complex and unique design task. This may explain why there is no city with a transport system map equal to another.

According to Cain (2007) the lack of recognized design standards has also contributed to inconsistencies in the material produced by different agencies, resulting in an unnecessary source of user confusion.

Some attempts in this direction have been done by transport's agencies and research centers in North America and Europe (Infopolis2, TRL593, NCTR77710, TCRP45). Mostly based in the analysis of passengers' needs, these studies present valuable inputs and advice for constructing more functional navigational instruments. However they frequently show a lack of graphic awareness and in many cases overlook some critical design issues. (i.e. the selection of a suitable Font). The disassociation of these studies with down-to-earth design matters has evidenced a gap between empirical evidence and graphic (qualitative) craftsmanship.

On the other hand, more sensible literature on the subject is disperse in different fields of study, specially in thematic cartography, graphic design and typography. Unfortunately, graphic designers – usually responsible for producing these maps- are not necessarily familiar with basic cartographic notions, neither with the current scientific research on the subject (Mijksenaar, 1999). Aggravated in part by this state of affairs, the graphic quality of transport maps can differ greatly from one case to another, evidencing a great dependency on the experience and expertise of the mapmaker. It can be argued that in many cases the design of Public Transport Maps seems to relay more on the intuition of mapmakers rather than on structured knowledge –leaving this fundamental public instruments susceptible to personal arbitrariness.

Paradoxically an increasing demand for more comprehensive graphic guidance in constructing Public Transport Maps has been originated from scientific research. For instance, computer scientists such as Avelar, Hurni, Wolff, Barkowsky and other experts interested in the automatization and visualization of public transport networks have noticed the importance of counting with such a design instrument to complement their experimental models. They have also realized the role of map designers in creating an aesthetically pleasing and easily understandable cartographic representation of a public transport network for thousands or millions of passengers (Avelar, 2008).

According to designer Paul Mijkseenar *neither scientific research not aesthetic quality guarantee the visual quality of Public Transport Maps. Visual quality is the result of knowledge of and craftsmanship in applying all available graphic means as effectively and in as balanced a way as possible. But that in itself is no guarantee of aesthetic quality. And although a good design distinguishes itself from a bad one by the extra value added to the sum of its parts, it is worthwhile having a closer look at some of those separate parts.*

In this context a revision of cases, the analysis of main issues as well as the identification of design elements and graphic operation emerge not only as a desirable but also as a necessary undertaking.

1.2 STATE OF THE ART

Although graphic designers and cartographers have projected most of today's Public Transport Maps, design investigations and literature on the subject are fairly limited and disperse in other fields of studies.

While Public Transport Maps have been a neglected field in cartographic literature (Morrison in Avelar, 2008), a main problem in graphic design seems to be the lack of interest and familiarity of many mapmakers with the results of theoretical and scientific research (Mijksenaar,1999). According to designer Paul Mijksenaar, many designers presume that innovative creativity is more important than its practical use and consequently, the usability of the information contents of a design has been undervalued. Perhaps this explains the scarce presence of designers in the discussion on the subject.

During recent years, Public Transport Maps have become the subject of substantial academic studies, experiments and publications, especially from disciplines such as cognitive science, psychology and computer science. Mainly oriented to the study of schematic maps, these studies have focused in perceptual and cognitive aspect of spatial orientation and lately in the impact of new technology in map production.

Most of this investigations have converged in the analysis of metro system maps, particularly in the case of the London Underground diagram: its history, its symbolic connotation, its perceptual and cognitive characteristics and its diagrammatic principles.

Historical Readings

The original map for the London Underground published in 1933 has influenced the shape of many of today's Public Transport Maps. Mark Ovenden's book Transit Maps of the World (2005) demonstrate –through a comprehensive collection of historic and current maps– how many of its graphic principles have been adopted in most of the underground systems around the world. But –as it will be discussed further in this thesis– it is not necessarily the only suitable way of representing public transportation networks to users.

The historical evolution of this paradigmatic case has been registered by three complete studies: Leboff, D. and T. Demuth's No Need To Ask! Early Maps of London's Underground Railways (1999), which study London "pre-diagrammatic" Underground maps from 1867 to 1932; Ken Garland's Mr. Beck's Underground Map (1994), which describe the care, craft, thought, and work behind Harry Beck's introduction of schematic principles in the design of the underground diagram (Tufte, 2002); and Maxwell Roberts' Underground Maps After Beck (2005) which reviews the successive changes suffered by the diagram, until today's version.

Garland – probably one of the most cited authors on the subject – focuses on the conditions, the historical context and the consequences behind the introduction of Beck's design, discussing how his diagram changed people's mental map of London. A more critical approach is taken by Roberts - a psychologist interested in studying how maps can affect users' decision making- who looks at the graphic evolution of the diagram until today's version, demystifying many of the assumptions about this map. Roberts analyzes chronologically several design strategies introduced by different mapmakers in relation with the growing complexity of the network and its users interaction/acceptance. He goes even further presenting and projecting alternative versions to the official diagram, suggesting room for improvements. Roberts' contribution to the current discussion on the subject has been expanded through his complete online archive and various articles.

Critical Readings

The design of the London Underground diagram has also been approached as a wider cultural and semiotic phenomenon. Many authors, such as Forty (1995), Hadlaw (2003), Vertesi (2008), Elliman (2006), Turnbull (2007) and Eco (1985), have taken this Public Transport Maps as a reference to expand the "mythology" and the symbolic meaning that has grown up around this influential graphic artifact (Hadlaw, 2003).

For example, in Object of Desire design historian Adrian Forty (1995) looks at the history of the Underground diagram in terms of the social circumstances in which it was produced. He contextualized its design as part of a comprehensive and innovative institutional strategy that unifies, not only the modern identity of London public transport system, but of the city itself.

Proposing a more exploratory approach, Paul Elliman (2006) argues how the electrification of cities in the early 20th century was the technological driver behind the London Underground system map of 1933.

Janin Hadlaw (2003) goes even further interpreting the London diagram through the texts of Barthes (1972), Lefebvre (1992), Wood (1986) and other contemporary thinkers, discussing how it became -such as the gothic cathedral- a "supreme creation" that epitomize modern ideals of space and time.

Turnbull (2007) expands some of these ideas contrasting the Underground Map with Chartres Cathedral as two examples of "performing design". Turnbull analyses how the diagram was designed, accepted as traditional, and how it informs our perception of urban space.

Eco (1985) - discussing the impossibility of Pierce's sign typology- also employs the London Underground map as an example in a semiotic game, changing and assuming different roles as a sign function, though always realizing its nature of something standing for something else by virtue of ever-different modalities of sign production. According to Eco the map can be interpreted as an iconic device referring back to the "real" layout of tracks in the city. But it can also be seen as the result of a symbolic convention which translates the uneven, fragmented route of tracks into a series of straight one-dimensional lines and the complex interrelation of switch points, connections and stations into plain colored circles. He continues, giving the map other signifying purposes such as interpreting its construction (a map for map's sake), or the map as a reminder of personal experience.

Beyond its graphic characteristics, most of these authors coincide in reading the London Underground diagram in terms of relations of meaning, power and of cultural practices, preferences and priorities. They also agree in assigning to the London diagram a fundamental role in shaping a collective idea of modern urban space and constructing its image. In this context, Public Transport Maps have been positioned between creating and recording the city, so far more than a functional instrument - aid to fixing destinations or following routes- it is bear of urban meaning and character: the map becomes to some degree the territory (Cosgrove, 2006).

Public Transport Maps as the Image of the City

The image of the city as a concept was coined after Kevin Lynch's classic book, named the same way (1960). In this book, Lynch examined the visual quality of some cities by studying the mental image of the city, held by its citizens (Cognitive Map). He concentrated especially on one particular visual quality: the apparent clarity or "legibility" of cityscape, which can be understood as the ease with which its parts can be recognized and can be organized into a coherent pattern (Lynch, 1960; Grabler et alt., 2008).

Lynch thesis presumes the possibility to develop our image of the environment by operation on the external physical shape as well as by an internal learning process. This view doesn't differ much from the one of mapmakers while projecting "legible" and comprehensible maps. Although Lynch did not referred explicitly to the role of Public Transport Maps in his book, he suggested that "a detailed analysis of the 'imageability' of subway systems, or of transit systems in general, would be both useful and fascinating." Lynch considers imageability, "that quality in a physical object which gives it a high probability of evoking a strong image in any given observer" (Lynch, 1960).

Janet Vertesi (2005) takes Lynch's theory a little further demonstrating how the London Underground diagram has become for its users the representation of the city itself. Coincidently, Ovenden (2005) argues that, more than anywhere else, the London Underground diagram forms a mental map of the city for both residents and tourists. According to him, it is difficult to imagine an image more integrated into the very psyche of a population. Despite being nothing more than a piece of paper with colored lines, this diagram has become what *London is.*

A paradox with the case of the London diagram is that it barely represents any visual elements of the city. An abstract Thames River seems to be the only landmark that refers to the city. But –as it will be developed ahead– the diagram makes legible an unimaginable urban space such as London's irregular street configuration. Above all, the London Underground map seems to represents the imposition of simplicity on "complexity" (Garland, 1994).

Another aspect that relates Lynch with the work of mapmakers is his approach to the city through the appropriation of such a graphic notion as "legibility". Legibility for designers can be understood as the degree at which glyphs and vocabulary are understandable or readable based on appearance. In a similar way Lynch has stressed the importance of the legibility of the environment, of which visual access is one part and maybe the complexity of spatial layout another. According to him good legibility of the environment improves spatial orientation and thus wayfinding. Although we could apply the same logic to Public Transport Maps (i.e. good legibility of a map improves spatial orientation) we should also consider the graphic nature of maps. As in the case of the Beck's London diagram, legibility of a map does not only depend on the right representation of urban elements in the space (i.e. paper, screen) but also in the correct recognition and perception of glyph and graphic forms (i.e. text and symbols). Therefore we can argue that a good legibility of a Public Transport Map should imply a compromise between these two variables. In other words, not all legible maps necessarily become the image of the city they represent.

An interesting counterpoint –further reviewed by Bierut (2004), Heller (2004), Bronzaft et al. (1976), Mijksenaar (1997; 1999) and Hustwit (2007)- is the case of the 1972 New York subway map, which according to its designer was "the most clear and legible ever seen in terms of information", but failed in matching user's conception of the city (Vignelli in Hustwit, 2007).

Wayfinding

Lynch has also been credited for introducing another key concept for transport maps: *wayfinding*. This concept refers to the process of moving (navigate) through space and encompass the goal of reaching a spatial destination. (e.g. Garling et al., 1986; Downs & Stea, 1973; Kaplan, 1976; Passini, 1998).

Wayfinding involves cognitive and behavioral abilities, which are performed to reach a destination (Arthur & Passini, 1992; Lawton et al., 1996, Casakin et al., 2000). In order to reach a destination, decisions have to be transformed into actions. It is in this process that decision execution takes place in a specific position within a certain environment. According to Arthur and Passini (1992) and Passini (1984) the execution of a decision involves the matching of a representation (mental or external) of the environment with the real environment itself. Both decision making and decision execution are supported by information processing.

Spatial perception (related to the process of acquiring knowledge from the environment) and spatial reasoning (related to the manipulation of spatial information) constitutes the main interrelated components of information processing (Passini, 1984; 1998). In spatial problem solving, a map is seen as a base of knowledge instrumental for supporting information processing (Casakin et al., 2000).

Reading navigational maps, such as Public Transport Maps, can be considered a complex task composed of relatively simple cognitive subtasks. Among these subtasks, Looben mentions: identifying symbols, route planning and locating ourselves on the map. Therefore, a key question for constructing Public Transport Maps is which aspects are suitable for solving wayfinding problems. Identifying these aspects is what turns these maps into an ideal tool for supporting navigation and orientation (Casakin et al., 2000).

Different wayfinding situations require different support. According to Freksa (1999), support is not for free: a certain effort is required to generate situation-adequate support and to communicate it to the waysearcher. Thus, in determining adequate wayfinding support for a given situation, we first must understand what kind of wayfinding situation we are looking at. A wayfinding situation involves:

- at least one search object in a given environment,
- at least one starting position for the search process,
- at least one search instance,
- at least one possible route,
- at least one waysearcher, and
- zero or more external supporters.

For Freksa wayfinding situations can be characterized as:

- simple or complex search situations and
- time-critical, space-critical, or uncritical search situations, and we can distinguish
- well-informed or uninformed searchers and
- smart or helpless searchers.

Furthermore, cultural dispositions, sensory abilities, orientation abilities, and individual mobility may influence the choice of an appropriate way. Each of these conditions may differ for a specific wayfinding support situation. Acknowledge these situations and dispositions is necessary for projecting more effective and efficient navigational instruments such as Public Transport Maps.

Today wayfinding has become a concept most often used in literature to encompass the perceptual, cognitive and behavioral processes involved in reaching destinations (Passini, 1999). Since finding a way (i.e. in a Public Transport Map) is concerned with perceiving, understanding and manipulating (designing) space, this concept has become a common ground for multidisciplinary studies.

Maps designed as wayfinding tools are specially intended to assist in navigation and improve accuracy in movement through the environment. Maps designed as wayfinding tools generally focus on a variety of wayfinding cues. Agrawala (2001a) stresses that the most important features for route maps to communicate are the points of reorientation, where someone must consciously turn from one path (route) to another. (Mooney2003)

Design research has often approximated wayfinding in the context of navigational systems for urban or architectural (and lately virtual) spaces (Passini, 1999; Mollerup, 2005; Correa de Jesus, 1994). Consequently, maps are often considered one of the components of a larger graphic support system. Although Passini, Arthur, and other authors have been studying a broader implication of wayfinding for decades, most recent design publications on the subject tend to focus mainly on signage (i.e. Calori, 2007; Uebele, 2007; Smitshui jzen, 2007).

Cognitive Cartography

For Daniel Montello (1995)-a prolific researcher in the field of visual-spatial thinking- cognition deals with knowledge, its acquisition, storage, retrieval, manipulation, and use by organisms or machines to achieve behavioral goals. Cognition includes structures and processes involved in perception, learning, thinking, memory, reasoning and problem solving, and language. Therefore, spatial cognition –according to Montello- refers to these structures and processes when they deal with spatial knowledge: Knowledge of location (including distance and direction), size, shape and pattern, as well as changes in these properties across time.

Montello (2002) divided the study of cognitive map-design in three main areas: map-design research, map-psychology research, map-education research.

The first area -map-design research- is primarily done by academic cartographers and its goal is the understanding of maps, mapping and map use in order to improve them (make them more efficient, effective and rewarding).

A second area of cognitive cartography is map-psychology research. The goal of this research, conducted primarily, but not exclusively, by academic psychologists, is the understanding of human perception and cognition (e.g., Lloyd and Steinke 1984; Tversky 1981 & 2000). Such research uses maps as stimuli, but is not necessarily concerned, even ultimately, with improving map design.

Finally, a third area within cognitive cartography is map-education research. This research has been conducted by researchers in cartography, geography, education and psychology who have had a special interest in improving education with maps and about maps.

While the third area seems to show less interest in studying Public Transport Maps, the first two areas (map-design and map-psychology) have produced considerable research on the subject. Much of this research has analyzed the London Underground map as a model to study the wide range of cognitive tasks involved in constructing and interpreting diagrams/ schemas; how this graphic piece can contribute to understand the nature of cognition; and how the understanding of human cognition can improve the design and use of maps.

A key text in the genesis of cognitive map-design can be found in The Look of Maps by cartographer Arthur Robinson published in 1952 (Montello 2002). Indeed this book has also become a decisive work for cartographers and most of the fields involved in map design. According to MacEachren (2004), Robinson's call for objective research on maps along the adoption in the 1970s of a paradigm of cartography as communication science, played a crucial role in establishing a research agenda for the study of map symbolization.

Robinson's Look of Maps

In The Look of Maps (1952), Robinson pointed out some limits to approaching map symbolization and design from a purely artistic viewpoint.

Robinson argued that treating maps as artistic pieces can lead to "arbitrary and capricious" decisions. Instead, he proposes two alternatives: either standardize everything so that there is no confusion about the meaning of symbols, or study and analyze the characteristics of perception and how they apply to maps so that symbolization and design decisions can be based on "objective" rules.

MacEachren – a leading figure in today's cartography- suggests that many cartographers did not consider seriously the establishment of standard symbols on thematic maps. Instead most academic cartographers took up Robinson's second option of formulating "objective" rules.

Robinson's dissertation, then, marked the beginning of a more objective approach to map symbolization and design based on testing the effectiveness of alternatives - an approach that followed positivism of physical science. In his work, Robinson cited several aspects of cartographic method for which he felt more objective guidelines were required (e.g., map structure, map design and lettering). He also suggested that this objective look at cartographic methods should begin by considering the limitations of human perception (MacEachren, 1994).

Although Robinson's notions responded to a different historical context, his contribution to contemporary mapmaking seems to be as valid and pertinent today as in his time, especially confronting the apparent homogenization introduced by computer-generated maps in areas such as public transportation.

This thesis considers some of the visual characteristics delineated by Robinson, taking into account three "elementary" aspects of maps such as map structure, map design and lettering, to analyze the creation of existing Public Transport Maps around the world.

Semiology of Graphics

Another key figure in modeling the way maps are studied and constructed today is the French cartographer Jack Bertin. His most influential work, Semiology of Graphics (1967), attempted to develop an organized set of principles for graphic design based on semiotic logic. Considering that specific types of symbols in maps have functional association with specific types of data, Bertin developed a theory of cartographic communication based on "visual variables" such as size, shape, value, orientation, hue, and texture. Bertin's theory has been subsequently modified by others (i.e. MacEachren, 1994), which differ primarily in the inclusion of three-dimensionality and the use of perspective (Slocum et al. 2004), both issues that will not be discussed in this thesis since its focus is primarily on static printed maps.

Understanding visual variables and their function can support maps' authors typify an effective symbol scheme from a wide, and often confusing, array of available symbols (Monmonier, 1993). As it will be developed further in this thesis, the form of symbols in Public Transport Maps can vary from map to map. However, the recurrence of certain shapes and graphic solutions allows the identification of certain categories, specially in points and lines, probably the most significant symbols in these kind of maps.

Cartographic techniques

Transport maps are among the most important and influential cartographical work in the world (Mooney, 2003). However- with little exception- cartographic literature has not showed particular interest in the design of Public Transport Maps. In fact, neither Robinson nor Bertin made a direct reference to the design of these maps. Morrison (in Avelar, 2008) has expressed his disappointment with the way cartographic publication generally has ignored the subject and Klippel et al. (2005) has discussed how some cartographers reject the notion of a special class of maps called *schematic*.

Perhaps the apparent indifference of certain cartographers with the subject relates to the difficulty of approaching such a wide variety of Public Transport Maps as a genre. In fact, these maps can depict routes in many different forms: from conventional cartographic "maps" (i.e. Milan's transport network map, ATM Citta di Milano), to very schematic "diagrams" (i.e. Stockholm metro). While cartographic maps are intended to represent the transport system contextualized in the real world as faithfully as possible, schematic maps are seen as conceptual representations of the network and its connectivity.

According to most cartographic literature, a map has three basic attributes: scale, projection, and symbolization. Although all these elements are a source of distortion (Monmonier, 1996), many Public Transport Maps stress, and in many cases simply omit, some of these cartographic attributes (i.e. the lack of geographic scale in most schematic maps). Thematic cartography usually refers to these maps as linear cartograms (Dent et al. 1993; Slocum et al., 2004), which -according to Monmonier (1996)- are among the more effective and highly generalized maps.

Cartographic generalization is the process of reducing the information content of maps due to scale change, map purpose, intended audience, and/or technical constraints (Slocum et al., 2004). In the case of Public Transport Maps, a variety of generalization techniques -such as simplification, exaggeration, displacement, etc.- can be used to emphasize links, adjacency, relative position and other attributes more important for the purpose of the map than geographic accuracy. Based on Thematic Cartographic literature –especially on the work of Dent (1993); Slocum, MacMaster, Kressler and Howard (2005), chapter 7 reviews how these and other graphic operations and techniques are applied in different Public Transport Maps to enhance their particular purpose.

Maps elements, variables and graphic operations (generalizations) are applied in the design process of public transport maps regardless the technology available. According to Avelar (2002) this process can be performed by different methods:

• **Manual:** the map-maker produces sketches by hand searching for the most pleasing graphical solution without loss of topological information of the network. The network is adjusted and readjusted until the map readies a satisfactory state. This is a quite labor intensive and impractical method.

• **Assisted:** drafting software is applied to support the map drawings by computer. In general, the original road network is scanned or digitalized to be used as background to the drawing and design of the new schematized lines. This method requires the same decree of visual scrutiny as the manual one, because it is still a procedure of trial and error attempts, but results can be obtained more quickly, attempts can be stored, and output to paper can be easily arranged.

• **Automatic:** specific approaches are used for automating the schematization process from a spatial database, e.g., iteratively relaxing spatial and cartographic constraints of more detailed routes;(Cabello and others 2005; Avelar 2002; Agrawala and Stolte 2001). The automatic method has the advantage of the graphic and analytic possibilities of a vector-based system, improving results more easily and making the production of schematic maps faster and cheaper.

Computer Science & Automated Maps

Perhaps, one of the fields of study where the design of Public Transport Maps has evolved the most in the last years is Computer Science. The rapid development of information technologies in cartography has lead to the so-called automatized cartography research field. Initially research consisted of automating certain tasks originally done by cartographers; later, the area incorporated the research on Geographic Information Systems (GIS) (Cabello, 2004).

The rise of GIS has increased not only the number of those involved in making maps, but also the diversity of automated maps. For example, many GIS nowadays offer packages for the schematization of line-based networks (Avelar, 2008).

The automated construction of schematic maps for public transportation has become a prolific field of research. The London Underground map emerges again as the main reference in numerous papers on the subject (Elroi 1988a, 1988b, 1991; Avelar et al. 2000; Barbowsky et al. 2000; Cabello, 2004, etc.).

Although there is a strong interest in automatizing the complete mapmaking process, computer-aided cartography still cannot match the quality of human expert mapmakers (Mooney and Winstanley 2003). The automatic production of schematic maps for public transport has in general focused upon the modification of network lines, without considering other design characteristics proper of this kind of maps (Ware et al., 2006; Stoltt and Rodgers, 2005; Barkowsky et al., 2000; Avelar et al., 2000). The schematization of lines is an important design element in the visualization of transport routes, but not the only one, since the map should also contain other cartographic features (Avelar and Hurni, 2006; Morrison, 1996; Garland, 1994). According to Avelar (2008) it is still necessary to choose adequately which elements should appear in the map background and to provide an effective cartographic/graphic representation for all map elements.

Another problem with computer-generated maps is that they are often cluttered with information irrelevant to navigation. This extraneous information, such as the names and locations of cities, parks, and roads far away from the route, often hides or masks information that is essential for following the route. The clutter makes the maps very difficult to read, especially while traveling. (Agrawala, 2001)

However in contrast to hand-assisted designed route maps, computer-generated route maps are often more precise and contain more information. Yet these maps are more difficult to use. According to Agrawala (2001) the main shortcoming of current systems for automatically generating route maps is that they do not distinguish between *essential* and *extraneous* information, and as a result, cannot apply the generalizations used in hand-designed maps to emphasize the information needed to follow the route. (Agrawala 2001)

Taking forward this discussion, Wolff (2007) ask why maps drawn by graphic designers still appear more pleasing and elegant than the best automatically generated maps. For him there are two main reasons: First, today's automatically generated drawings are the result of academic feasibility studies, not the output of professional tools. Therefore, they lack the finishing touch that professional graphic designers apply to their drawings such as proper fonts and colors, rounded bends, special symbols for interchange stations, line breaks in labels etc. Secondly, and more important, a professional graphic designer uses background knowledge that is not available to the current algorithms; he/she, for instance, sees symmetries or knows underlying structure (such as the circular lines in London or Moscow), and can stress or otherwise take advantage of these elements in the layout process. He concludes stating that a good layout of a complicated subway system is (still!) a piece of art, and thus may be out of reach for complete automation (Wolff, 2007).

Although the design of automated maps still seems to be unsuitable for a large audience, the rapid development of technologies is introducing new variables and opportunities in the design of Public Transport Maps. Interactive journey planners offered by transport agencies through the world wide web, Goggle Transit and other electronic applications are certainly challenging the conventional role of printed material and the way Public Transport Maps has been traditionally design.

Visual Quality

Designer Paul Mijksenaar (1999) points out that in this scenario one could expect that designers of the future will be restricted to designing the legend of computer generated maps. However he also recognizes that mapmakers, while preserving functionality, can add much visual quality to a map, arguing that attractiveness in itself represents a functional aspect in the case of public graphics.

"Visual Quality" in map design is a difficult concept to grasp under objective criteria and objective measurement. Mijksenaar (1999) defined this concept as *the result of knowledge and craftsmanship in applying all available graphic means as effectively and balanced as possible.*

Both, Agrawala (2001b) and Tufte (1997), provide insights of the properties of effective route mapping. They identify several key design goals that can be summarized as follows:

• **Readability:** All essential components of the route especially the roads, lines, etc., should be visible and easily identified

• **Clarity:** Routes must be clearly marked and readily distinguishable at a quick glance. The map should only contain the amount of information necessary to highlight the chosen route.

• **Completeness:** All information necessary for navigation must be provided.

• **Convenience:** This goal is applied to route maps used while traveling. They stipulate that route maps should be easy to carry and to manipulate. Mooney explains that in the case the map is intended for the Internet, this aspect relates to the browser window.

Map designer, while preserving functionality, can add much aesthetic quality to a map. This does not necessarily make maps any better but they can become much more attractive. Mijksenaar argues that this attractiveness in itself forms a functional aspect in the case of public graphics, at least according to the AIDA formula: Attention, Interest, Desire, and Action.

For map critic John K. Wright the quality of a map is also in part an aesthetic matter. Maps should have harmony within themselves. An ugly map, with crude colors, careless line work, and disagreeable, poorly arranged lettering may be intrinsically as accurate as a beautiful map, but it is less likely to inspire confidence (Quoted in Dent, 1993).

Three elements have been identified as forming the basis for the evaluation of map aesthetics: harmony, composition, and clarity. Harmony is viewed as the relationship between different map elements or how do the elements look together. Composition deals with the arrangement of the elements and the emphasis placed on them, in other words, how does the structural balance of emphasis appear. Finally, clarity deals with the ease of recognition of the map's elements by the map user. "According to Dent (1993) "a map which lacks one or more of these three main elements lacks beauty."

Dent also agree in mapmakers certain degree of freedom in their design process: *of course map function and the needs of the user are the overriding concerns, but beyond that the designer is working in a subjective realm. How well he or she performs in the creative, aesthetic realms will likely depend on intuitive judgments, conditioned by fundamental training and experience.*

Diagrammatic Dimention

Diagramming can be considered a foundational discipline of visual communication (Horn, 1999, Anceschi, 1992). Public Transport Maps and diagrams are simplified representations of events and objects, therefore they are part of visual communications (Anceschi, 1992). Visual Communication can be defined as the integration of words, images, and shapes into a single communication unit (Horn, 1999). A large number of authors and disciplines have contributed in time to the study of visual communication providing different vocabulary, syntax and semantics models. (Anceschi, 1992; Arnheimm, 1969; Bertin,1967; Bowman,1968; Engelhardt, 2002; Horn, 1999, Richards, 1984; Rogers 1989; Tufte 1983, 1990, 1997; Tversky, 1995, 2001; Twyman, 1979).

In the last years computer and cognitive scientists seems to be taking advantage of these theoretical corpus of knowledge - usually considered to be foundational for disciplines such as graphic design.- proposing comprehensive frameworks that eventually could permit the further implementation of this information into practical applications. One noticeable framework entitle "A Taxonomy of Diagram Taxonomies" has been proposed by psychologist and computer scientists Alan F. Blackwell and Yuri Engelhardt (2001). This model reviews existing taxonomic studies of diagrammatic representation through the case of the London Underground diagram. This framework (resumed below) enables a comparative analysis of the various research endeavors done in this multidisciplinary field.

Signs - the components of a diagram

• ***Basic graphic vocabulary (1)***
The basic graphic vocabulary consists of the graphic primitive elements and the graphic properties that graphic representations are composed of. Example distinctions concerning this aspect are "point, line, area" and "color, size, shape".

Regarding the basic graphic vocabulary (1), Bertin's (1967) analysis of the graphic domain would suggest that the Underground diagram uses two "implantations": "points" (the stations) and "lines" (the connections). These encode information through two of Bertin's "visual variables": "shape" (types of stations), and "color" (different lines). Bowman (1968) would identify the same "vocabulary of form" in the Underground diagram as Bertin: "point, line, shape, color".

• ***Conventional elements (2)***
A common taxonomic distinction is between words, shapes and pictures. Where these conventional elements appear within diagrams, they generally represent meaning that is borrowed from another symbolic convention -- that of spoken language, for example. The simple distinction between words and pictures includes some element of our mode of correspondence (5), while that between shapes and pictures includes our pictorial abstraction (3). These nested symbolic conventions are also subject to taxonomic analysis: Werner and Kaplan (1963) and Sampson (1985) have both proposed classifications of words and symbols according to their mode of representation. Some words and symbols are apparently constructed from arbitrary smaller elements, while other words and symbols are constructed from smaller elements with meaning. Although this distinction is lost in taxonomies that refer to words, symbols and pictures as atomic elements, those elements can be reconsidered in terms of our other taxonomic aspects if the taxonomy is applied recursively to analyse diagram elements, even those that are at first sight conventional. An alternative, even further simplified version of the division between conventional elements such as "word, shape, picture" is the dichotomy "abstract vs. pictorial".

Regarding conventional elements (2), Twyman's (1979) analysis of "mode of symbolization" suggests that the Underground diagram contains both "schematic" elements (shapes, such as lines and marks) and "verbal" elements (words, such as the station names).

• ***Pictorial abstraction (3)***
Concerning the depiction of physical objects or scenes, a continuum of pictorial abstraction can be observed, from the very realistic via the schematic to the completely abstract.

Regarding pictorial abstraction (3), Richards (1984) describes the "mode of depiction" of the Underground diagram as "non-figurative", since it hardly contains pictorial signs, except maybe for the river Thames.

Graphic structure of a diagram

• ***Graphic structure (4)***
Graphic structure, also refered to as 'configuration', is concerned with the

organizational principles according to which individual signs are combined into a diagram. Example distinctions concerning this aspect are "linear sequence, two-axis-chart, table, tree structure".

Regarding graphic structure (4), Richards (1984) points out "organization" by "linking" (the lines) in the Underground diagram. Twyman (1979), in his spectrum from linear to non linear "configuration", regards the Underground diagram as a "non-linear" configuration with "directed viewing". Engelhardt (1998), analyzing "meaningful space", would point out the combination here of structuring by both "links" (the lines) as well as by crude geographic topology (the positions). In Lohse et al.'s "classification of visual representations", the assignment of the Underground diagram is not quite clear to us - it could be referred to either as a "map" or as a "structure diagram" or as a "process diagram" or as as a "network chart" in their classification system. Lohse et al.'s distinctions seem to consider both graphic structure (4) and the nature of the represented information (6).

Meaning

• ***Mode of correspondence (5)***
Mode of correspondence is about the kind of relationship between a representation and its meaning. Example distinctions concerning this aspect are "literal vs. metaphorical", "direct vs. indirect", and "iconic vs. symbolic". As both Arnheim (1969) and Eco (1985) have noted, these kind of distinctions do not concern types of signs, but rather types of sign functioning. In different contexts, the same sign may function in different ways, and therefore mean different things. For example, depending on the context, a drawing of a wine glass may stand for a wine glass (literal correspondence), for "bar" (metonymic correspondence), or for "fragile" (metaphorical correspondence).

Regarding mode of correspondence (5), Richards classifies the Underground diagram as "semi-literal". Eco (1985) points out that the Underground diagram is both "iconic" (in its reference to the layout of tracks through the city) and "symbolic" (in its use of plain circles for stations and straight unidimensional lines for the fragmented routes).

• ***The represented information (6)***
Various researchers have also classified the information represented by the diagram. This includes classifications of information domains and classifications of relational properties. An example distinction concerning information domains is "space, time, other". An example distinction concerning relational properties is "nominal, ordinal, quantitative".

Regarding the represented information (6), the Underground diagram may be considered to be a representation of "spatial" and "ordinal" information, or it may be taken to represent a "sequence of actions" required to reach a particular destination.

Concerning the context-related aspects of the Underground diagram, we note that there has been less empirical investigation of this diagram than there has been semiotic analysis. However, our list of aspects suggest several areas of investigation that could be pursued.

Context-related aspects

• ***Task and interaction (7)***
The activity of a person interacting with a diagram, the structure of the task, and the tools that are used to complete that task, are also subject to taxonomic classification. This aspect includes taxonomic elements related to computational tools such as diagram parsers and editors, as well as task classifications (e.g. drawing, sketching, transcribing, restructuring). Although these considerations normally concentrate on the style of interaction where a user is creating or modifying the diagram, complex diagrams may require physical interaction even to read them. This may involve some computer program, the user moving a finger to track long paths on a piece of paper, or even the process of directing one's gaze along a locus of visual attention.

Regarding task and interaction with the Underground diagram (7), we can conjecture about interaction with it on the basis of the observation that maps in the underground are worn out in a patch near the current station. Users presumably put their finger on that patch, then trace a route to where they want to go. The finger seems to be an essential tool for interacting with such representations.

• ***Cognitive processes (8)***
Many characteristics of diagram function are determined by the diagram user rather than by the representation, and these are reflected in taxonomic considerations of perceptual characteristics and support for cognitive function. The cognitive status of diagrammatic representations has led to classification of mental representations of diagrams, especially the contrast between hypothetical image-like mental representations and propositional representations. This aspect also includes the cognitive implications of diagram properties related to perception, interpretation and problem solving, as well as individual differences in ability, expertise or strategy.

Regarding cognitive processes (8), we note that perceptual attributes of the diagram, including line weights, colour discrimination, font legibility and so on are a prerequisite to its usability. The Underground diagram has also affected mental representations: according to Garland, it has changed people's mental map of distances across London. No doubt the many versions also accommodate interpersonal variation -- versions for use by the visually impaired, for example.

• ***Social context (9)***
Diagram users are not self-sufficient. Despite occasional naive claims regarding the inherently intuitive nature of graphics, the way that we interpret any representational conventions depends on cultural context as well as the conventions of particular media types. Analysis of a diagram must consider which information is present in the diagram, and which information comes from other sources. Furthermore, the content of a diagram must be considered in terms of its context in discourse.

Finally, regarding social context (9), the Underground diagram certainly has a complex cultural and communicative context. When the diagram is printed on a T-shirt, what is its diagrammatic function? The Underground diagram can also be used as a pragmatic substrate for other messages. For example, shops in London often use a customized version of the diagram in their advertisements, to highlight their location.

(Blackwell et al., 2001)

Sign (the components of a diagram) and the *Graphic Structure* of a diagram are –for Blackwell and Engelhard– the most common principle in diagram taxonomies, and are central to disciplines such as graphic design. It describes the organization of the display - distribution of ink and color. They also suggest the convenience of separating these description into consideration of individual marks or components (graphic vocabulary), and the way those components are related to each other (graphic organization) - even though the definition of a 'component' may vary in different taxonomies.(Blacwell & Engelhard 2001)

A main task for graphic designers in this scenario is to recognize a particular set of information, and prepare a way of communicating that information effectively. In order to do this, designers must have access to some set of possible design solutions. How can this set be systematized? What is the visual vocabulary available to the designer? These are the topics of research in graphic design. The visual vocabulary must be extended by a 'space' of possible spatial organization (set-up, lay-out, formats and technologies) for a given design problem. Graphic design also takes place within a social context: how does the map affect design decisions beyond the simple limitations of media type and the trivialities of graphical style? These are some of the issues this thesis will try to answer.

Public Transport Maps' Design

More applied studies from computer scientist Silvania Avelar and cartographer Lorens Hurni (2006) and Avelar (2008), present lucid overviews of main design considerations involved in the creation of Schematic Transport Maps. These investigations not only have promoted the research on Public Transport Maps but also denote the lack of design documentation and graphic guidelines on the subject.

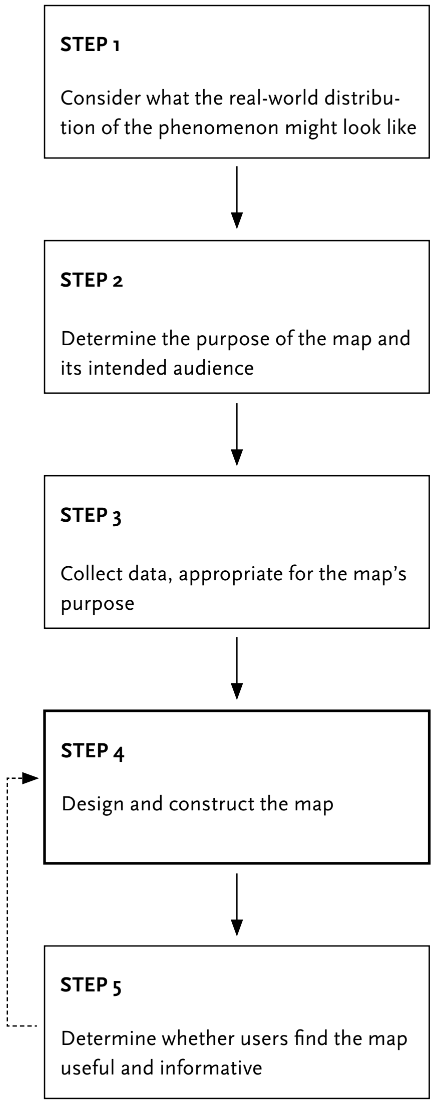
Probably one of the most complete academic studies on this topic that focuses on graphic aspects is "Public Transport Maps in Western European Cities" by cartographer A. Morrison (1996). The study analyzes the maps of 25 public transportation systems in 11 different countries, defining 4 different graphic styles. Morrison proposes a set of rules that govern the choice of a mapping method based on the types of transport modes, number and amount of overlapping transport services, for example. He also examines some design factors such as the degree of map details, map size and purpose, the importance of emphasizing name of terminus, the problem of insets, panels at interchange maps of districts, and finally provides guidelines for the construction of a map.

Other main source of applied research comes directly from public transportation agencies. Complete studies, surveys, technical reports, manuals and guidelines are available mainly from European and North American institutions (Higgins, L. & Koppa, R., 1999; Denmark, 2000; ATCO, 2000; Fallat, G., Sollohub, D., & Jeng, O-J., 2004; Cain, A., 2004; Cain, 2007; Mijksenaar, 1995; among others). Most of this research considers maps within the context of transport information systems and center their attention on user's travel requirements. For example, Infopolis 2 (2000), study carried out by a partnership of European agencies, analyzed quantitatively and qualitatively the tasks and information needs of multimodal travelers through the different stages of their trip.

Particularly valuable for this thesis have been three technical reports entitled *Design Elements of Effective Transit Information Material* (2004), *Developing a*

Printed Transit Information Material Design Manual (2007) –both produced by A. Cain for the National Center for Transit Research (NCTR) in the US- and *Uniforme beeldtaal openbaar vervoerplattegronden* (1995) produced by Bureau Mijksenaar for the Royal Dutch Transport (KNV) in the Netherlands. The first study mentioned above provides relevant information on user's performance with maps through tests; the second compares the graphic material of different transport agencies in the US, in order to determine where clear consensus exists and where there is contrasting advice. These reports also consider design guidelines for several information pieces such as timetables, route maps and system maps. The results of the tests and surveys included in these reports are discussed throughout the development of this thesis.

The third is an internal report that has the peculiarity of being one of the few studies carried out by a design studio (Bureau Mijksenaar). As part of a larger project that seeks the standardization of cartographic information for the Dutch public transport system, this report compiles and analyzes different graphic elements presented in maps with the aim of standardizing the quality of traveler information in the Netherlands. The compilation done by Bureau Mijksenaar has been used as a model for depicting and studying symbols in transport maps worldwide.



Basic steps for communicating map information to others (Slocum et al., 2005).

Map Design

The conception and creation of maps is a partly mental, partly physical process (Slocum et al. 2004).

The design and construction of a map can be considered as component of a more complex communicational model (Dent, 1996, Robinson et al. 1984). According to Slocum (ibid) design is situated in the four step of a Map Communication Process (Figure on the right), but it encompasses aspects of all five steps: from imagining the real-world distribution to evaluating the resulting map.

Map design involves the conceptualization and visualization of the map to be created, and is driven by two goals: (1) to serve the purpose of the map based on its intended audience and use, and (2) to communicate the map's information in the most efficient manner, with simplicity and clarity. Edward Tufte (1990) echoed this second goal, eloquently stating that *"Confusion and clutter are failures of design, not attributes of information."* The physical act of placing, modifying, and arranging map elements is often referred to as the separate activity of map construction, or *layout*. Because of the holistic nature of the design process, map construction is considered by Slocum et al. (2005) to be largely integrated with the cartographic design process.

Map design is directed in large part by rules, guidelines, and conventions, but is relatively unstructured. A single, optimal solution to a given mapping problem generally does not exist; rather, several acceptable solutions are usually possible (Slocum et al. 2004)."Good design is simply best solution among many, given a set of constraints imposed by the problem" (Dent 1999).

Although most map design research represents a scientific approach to understanding how maps work, the "art" of maps also plays an important role in cartographic communication. The artistic aspect of maps is guided less by experiment and more by intuition and critical examination (MacEachren 1995). It is difficult to anticipate the map user's sensitivity to the artistic aspects of a map. However, it seems likely that a map that has been created with an artistic synthesis of contrast, balance, color, and so on has a greater chance of communicating information than a map that has been created in the absence of an artistic sensibility (Slocum et al. 2004).

The role of Graphic Designers

The link between cartographic design and graphic design is strong. Graphic design has been described as "probem solving on a flat two-dimensional surface ... to communicate a specific message" (Arntson, 2003). Both cartographic design and graphic design emphasize the communication of information through graphical means (Slocum et al. 2004).

For many years, graphic designers have been involved in the projection of Public Transport Maps (i.e. Erik Spiekerman, Massimo Vignelli, Paul Mijksenaar, Ronald Shakespear, etc.). However, most designers are not necessarily familiar with many of the cartographic concepts and operations required to produce useful maps, neither with the current research on the subject. Most of the time, designers approach to maps is intuitive and the output relies principally in their experience and visual *(aesthetic)* sensitivity (Mijksenaar, 1999).

According to Mijksenaar (ibid.), there is often a conflict between the map designer's intentions and the user's needs. On the one hand there is the designer with his/her principles and a systematic way of working, and on the other hand there is the user who decodes the carefully selected and depicted information on the map. At this point, Mijksenaar argues that a human behavior specialist can be very helpful, since the researcher, just like the user, is not primarily interested in the aesthetics of the map or the reasons for depicting information in one way or another. In the design phase, a researcher is interested in the requirements a map should meet to be a useful aid in performing a certain task. In the evaluation phase, a researcher is interested in discovering the reasons why people have difficulties when using the map. For Mijksenaar the crucial question is: are people making design-related errors or task-related errors? In this cooperative approach to map design, the designer should expect to be flexible and willing to think of unorthodox answers, while not losing sight of visual quality through clarity and good organization.

These considerations underlie the importance of the map user's requirements as a factor in map production. With this in mind, Garland (1998) remarks ring become more truthful:

"No-one doubts that the invention of the London Underground diagram made an important contribution to the development of graphic design in the 20th century. There can be few, if any, other single work in this field whose influence has been so seminal and so enduring. Its lessons have to be learned the hard way: To be effective, information design must start, not merely end, with its users, their needs, their perceptions. The designer's function in this field is not to supply a quick fix but to be prepared to embark on a long haul"

The literature reviewed in this chapter has contributed to set a scientific and theoretical framework that could support the discussion and design decisions related with the creation of Public Transport Maps. However the gap between this "corpus" of knowledge and its practical execution still leaves many unresolved issues for mapmakers. Some of these issues will be identified and discuss through the rest of this thesis.

Chapter 2
Two Paradigmatic Cases

2.1 A BRIEF HISTORY OF PUBLIC TRANSPORT MAPS

Routes maps such as strip maps have been used as an aid in travel throughout recorded history. Most early route maps were of the strip map subclass, depicting routes in linear forms. Early examples of these maps, dating from about 2000 B.C., can be found in ancient Egyptian tombs and in the Roman route's itineraries. One of such an antique map are the Peutinger Tables that shows the "cursus publicus", the road network of the empire that covered roughly from Southeast England to Sri Lanka (Goss, 1993). It represented a list of stops along the route, such as villages, towns and cities, and the distances between them.

Although transport routes and networks are often depicted in the same manner as the Roman itineraries, it is during the nineteenth century -with the expansion of the railway- when most of today's graphic characteristics and forms of Public Transport Maps became recognizable.

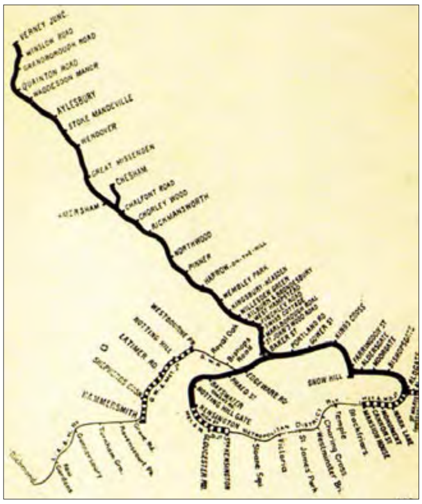
1889 London

It is during this period that transportation became the lifeline of industrial cities, ensuring that workers could get to their jobs, that life-sustaining and life-enriching goods could get to the marketplace. Whether powered by horses, steam, electricity, or petroleum, public passenger transit by rail and road became essential to the economy and quality of life in metropolitan regions (MTA - Transit Museum, 2008). Consequently, rendering this information accessible turned out to be crucial for both companies and general public. According to Ovenden (2005), as the complexity of rail networks grew, so did the way each operator informed passengers of their superiority over a competitor. Maps and posters were the key to gaining new traffic.

1874 London

Since cartographers had a hard time trying to keep track of the rapid expansion of railways the very first railway routes were often printed over existing plates of topographic maps. Although this operation worked fine with few lines, the over-printing technique began to show serious problems in networks such as London, Berlin and Paris where several lines overlap. In fact, there is often a multiplicity of routes concentrating densely crossovers in the central area of a city with stations in close proximity to one another, while in the suburbs the lines are less intense. This generates a severe restriction to truly geographical maps in terms of scale.

Mapmakers slowly began to recognize that underground users did not necessarily need to know exactly which streets they were traveling under when they are in fact below the surface. Already in 1874 a map of London's Metropolitan Railway removed almost all surface topography, including the street pattern. Similarly, by the late nineteenth century, Berlin had a complex system of urban railways and it also was depicted without surface features (Ovenden, 2005).



1896 London

Scale and legibility arose as key issues in the design of Public Transport Maps. Maps were becoming too difficult to handle and carry around, so the next step was to distort the true nature of the distance between stations. This change was crucial for the Metropolitan line in London, which had a number of stations less than one kilometer apart from each other in downtown, but up to 10 kms. away in the periphery. Their 1896 map introduces major distortion to squeeze the entire length of the line onto a single sheet (ibid).

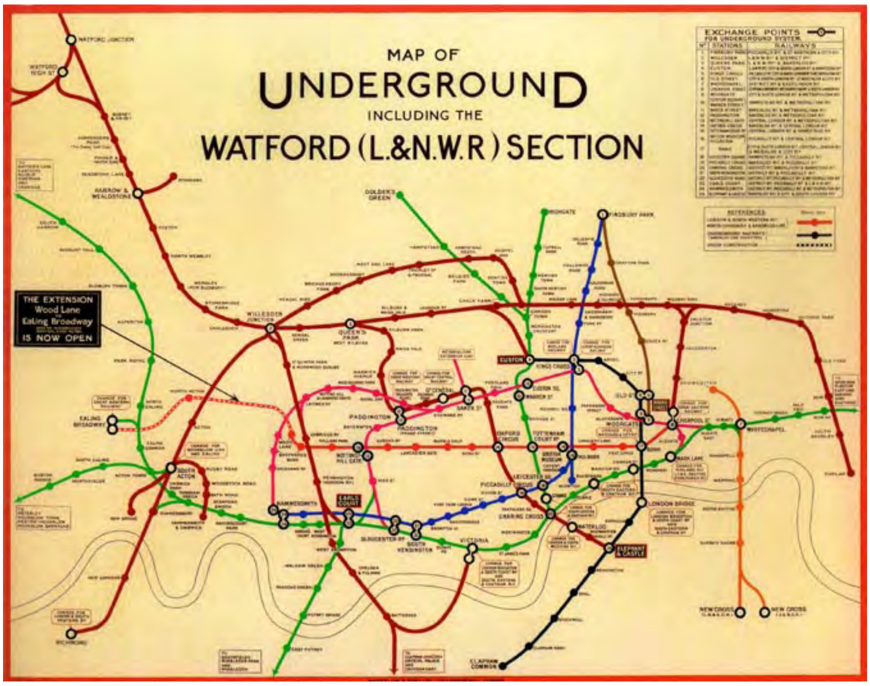
Map of Boston. 1926

The regular grid of most North American cities, like Chicago, initially present less of a problem enforcing a more even distribution of stations. However Boston's 1926 map removed all streets and topographical features and distorted the true length of lines. The same was true for London's 1917 map, which also introduced another crucial feature; it straightened out the bends and kinks of the tracks into neat straight or simple curved lines.

The 1931 diagram of Berlin's S-Bahn and the 1934 U-Bahn plan, show signs of the spread of diagrammatic design. But it was London that created the benchmark for Metro maps around the world. In 1933 the London Transport released Harry Beck's diagram, a much more simplified version by making the lines conform to a set of rules utilizing horizontal and vertical lines, and sparing use of diagonal lines at an angle of 45°, changing the way we look at transport maps nowadays.

Nevertheless, Roberts (2005) argues that the conventions adopted by the London Underground map are one way of presenting information, but not necessarily the only correct way of doing it.

Since 1930 -when the move towards diagrammatic mapping begun around the world- a multitude of styles and conventions have developed. The differences are not just in general features such as typeface and line thickness, but also in station and interchange symbols, angles and numbers of angles, and also the extent to which there is geographical distortion; surface details are shown; and modes and services are shown individually or grouped into lines.



Map of the London Underground. 1917

CASE 1: THE LONDON UNDERGROUND DIAGRAM

The London Underground diagram is probably the most studied and cited transport network worldwide. It has been extensively documented in many publications, academic papers, articles and exhibitions.

As background, the development of "The Tube', as it is affectionately known, began with the world's first truly underground line in 1863. By 1907 the core centre was in place, with the majority of subsequent development above ground, taking lines into suburbs and open countryside. London had to wait until 1968 for the Victoria line, and a further 30 years for the full realization of its most recent addition, the Jubilee line (Ovenden, 2005). Today, London Underground is a major organization with three million passenger journeys made every day, serving 275 stations over 408 km of railway, and 11 lines (Transport for London, 2008).

Pre-diagrammatic maps

The first few decades after the 1863 opening of the Metropolitan Railway, tracks were printed over existing street maps. The arrival of tube lines directly under central London's chaotic streets called for a different approach (Ovenden, 2005).

By 1906 London had a fragmented system owned and operated by separated companies, each one with its own map. All of them experienced financial difficulties and they attempted to save themselves by a scheme of through – booking to any station. (Turnbull, 2007). A year after the agreement between the major companies, the first "all-inclusive" maps of the network was published.

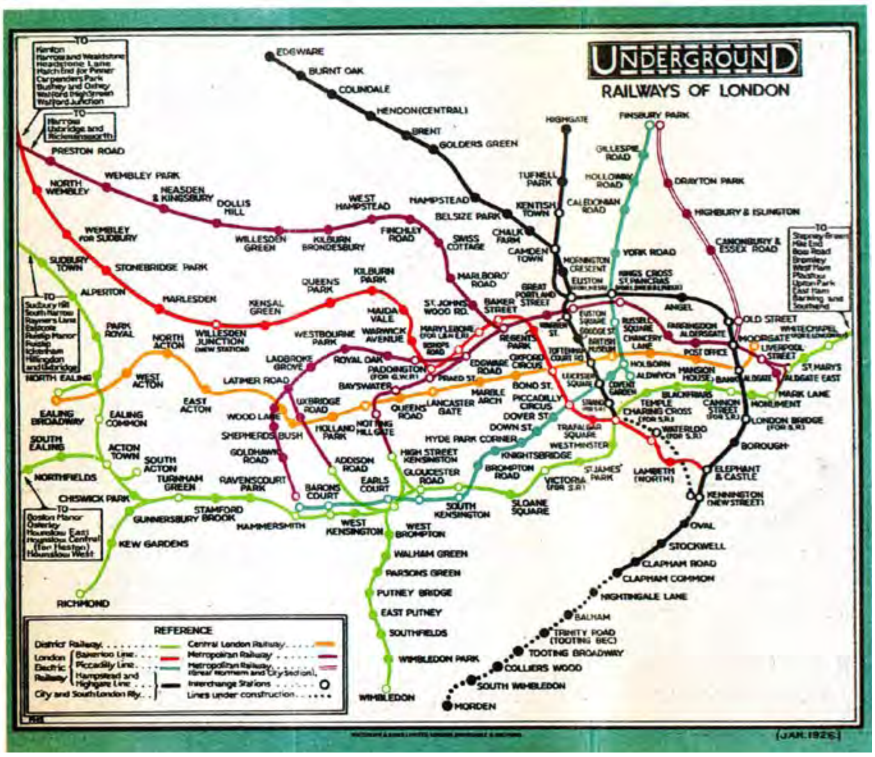
In 1908 the group of companies agreed to advertise the separate lines as a single system though remaining independent. In order to promote their join interests as "a complete system of underground railways" they decided the trading name "Underground".

London Underground Railways Map. 1908

According to Garland (1994), the first general map, issued in 1908, was admirable in its intention and no doubt very helpful to the traveler; but it presented an illusion of unity which did not exist at the time. A series of maps produced by each operator showing its own lines highlighted over an undifferentiated network evidenced that the independence between companies was still being maintained in the display of information. This situation remained so into the early 1930's.

These first maps already illustrated a serious problem confronting the Underground cartographers: the progressive extension of the network. Perhaps for this reason the Underground Group started to indicate interchanges with main-line termini. Nevertheless with the decision to limit the expansion of the system, mapmakers had to struggle making sense of the intricate web of connections in the central area which each time was becoming smaller in scale and less useful for travelers.

In 1926, F. H. Stingemore, a draughtsman from the Underground Group, introduce in a card folder a map with some topographical distortion, presenting portions of the routes compressed in comparison with the central area . Probably, Stingemore realized it would be impossible to present the traveler with a sensible map in pocket size format unless he employed such operation. In fact most of the Underground maps since the 1908 contained some kind of distortion, what indicate a local tolerance, and acceptance of geographical inaccuracy in relation to underground routes maps.



Underground Railway of London Map. 1926

Another important feature of Stingemore's card folder map was the elimination of all surface detail. For Garland (ibid.), this undoubtedly assisted its clarity, but introduced some ambiguity and confusion with the station lettering (names) in the central area. In a later edition (1932) Stingemore slightly expanded this area and added the river Thames – probably in response to the public's continuing difficulty in deciphering the map.

By the early 1930's the problems of representing the increasing complexity and expansion of the network were becoming acute. Stingemore's efforts, though resourceful and well intentioned, provided no more than a partial answer.

The Underground Identity: Frank Pick

For years, the Underground Group had taken over smaller companies running bus and tram networks in London. In 1933, all the city's transport companies – five underground railway companies, seventeen tramways and sixty-six bus companies – were merged into one, the London Passenger Transport Board.

Station Furniture for London Transport, incorporating "roundel" logotype. 1933

Frank Pick, the former head of the London Underground in the 1910s and 1920s was appointed as managing director of the new company. Pick wanted to give the public the impression that the 'Underground railways were no longer a disparate and unplanned agglomeration of lines but that they had become part of an orderly and centrally planned system' (Forty, 1995). He hoped thereby to encourage more travel and to establish an integrated organization and workforce.(Turnbull) In order to fulfill this aim he introduced a series of innovative design policies that integrates advertising, publicity, signage and architecture, reshaping London transport's identity. According to design historian Adrian Forty, Pick was one of the first in realize the importance of implementing a corporate design program as an strategy to consolidate the company- a complete innovation at time.

Pick has been credited -among other contributions-of being behind the creation of the first version of the system "roundel" logotype (1908) and the Underground unique san-serif typeface (1913-1916)- both commissioned to calligrapher Edward Johnston. While the underground logo became an example of corporate symbol, enduring as one of the most effective and popular in use anywhere in the world today (Glancey, 2008); Johsnton's "Underground" typeface- a fusion of sans-serif and roman patterns- was a complete broke with the Victorian precedents by applying a strict classical awareness of forma to the letters, involving an integration of geometric thinking that anticipated the work to be produced on the 1920's influencing other seminal faces, such as Futura and Gill (Blackwell, 2004; Howes, 2000).

Capital letters of Edward Johnston's 1916 typeface for the Underground Electric Railways of London. The Typeface was adopted for all London Transport' lettering including maps.

As a managing director of the newly-formed London Passenger Transport Board one of Pick's priority focused in facilitating passengers navigation through the new network. Therefore a central component in Pick's campaign to train people to see the Underground as a seamless coherent network and London as an intelligible and accessible whole was the design of a new Underground Map (Turnbull, 2007).

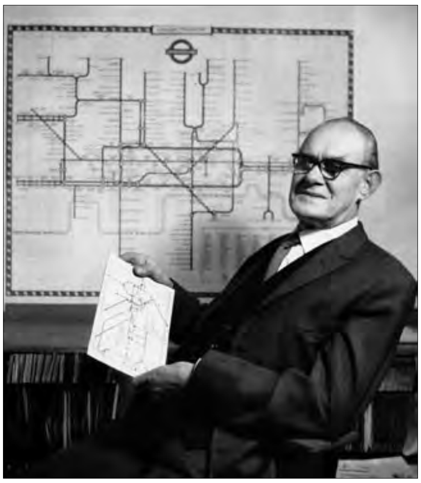
By the early 1930s, the London Underground network had expanded so much that it was increasingly difficult to squeeze all the new lines and stations into a geographical map. Passengers complained that the existing map was crowded, confusing and hard to read. The network was too big to be represented geographically (Design Museum UK, 2006).

The challenge of merging these companies into a coherent network -which could then expand to meet the fast-growing city's future transport needs- along Pick's design policies, create an ideal scenario for a more radical approach. According to Garland (1994), it was the time for a more drastic solution.

Beck first version of the Underground Diagram. 1933

Beck's Diagram

Despite the slow evolution of the map from the first geographically accurate "spaghetti-like" representations of the Underground, it was still quite confusing and made it difficult to plan a journey using the now unified system. Unintimidated by cartographic convention, Harry Beck, an electrical draughtsman from Finchley who was at that time temporarily employed by the London Underground Signals Office, to create a simplifier version that set the principles of today's diagram (in BBC:People Who Shaped the London Underground, 2006).



Harry Beck in 1965, holding the exercise book sketch made in 1931 with his diagram.

He used only vertical, horizontal, or 45 degrees angled colored lines; located the stations according to available space; and evened out the distances between stations (Rajamanickam, 2005). The only slightly realistic element included in the map was the Thames river- according to Mijkseenar (1999)- a clever use of landmark that helps the user interpret the diagram. The resulting "map" although geographically inaccurate, provided a coherent overview of a complex system.

Describing his diagram concept Beck comment:
"Looking at the old map of the Underground railways, it occurred to me that it might be possible to tidy it up by straightening the lines, experimenting with diagonal and evening out the distance between stations. The more I thought about it the more convinced I became that the idea was worth trying, so selecting the Central London Railway as my horizontal base line I made a rough sketch. I tried to imagine that I was using a convex lens or mirror, so as to present the central area on a larger scale. This, I thought, would give a needed clarity to interchange information" (Beck cited in Garland, 1994).

The map was an instant success for Londoners and rapidly structured their image of the city. According to Tufte (2002) "the map organized London, rather than London organizing the map"

Beck's map was produced on a trial basis in 1933 as a leaflet and Beck continued to refine it until 1959. His design has inspired the maps of many maps around the world and a variation of his original design is still used by London Underground today.

Becks Fundamental Achivement: Design Rules

The success of Beck's diagram is due to two design strategies:

First, the map places importance on function over precise geography. A commuter is interested in how to go from one station to another. All he needs to know are: which line to take, where to change lines, and what are the preceding stations. The map fulfills this need by simple lines (which ensure an uncluttered layout), color (which differentiates the lines), clear typography (which makes text easy to read), and symbols (which differentiate stations from interchanges).

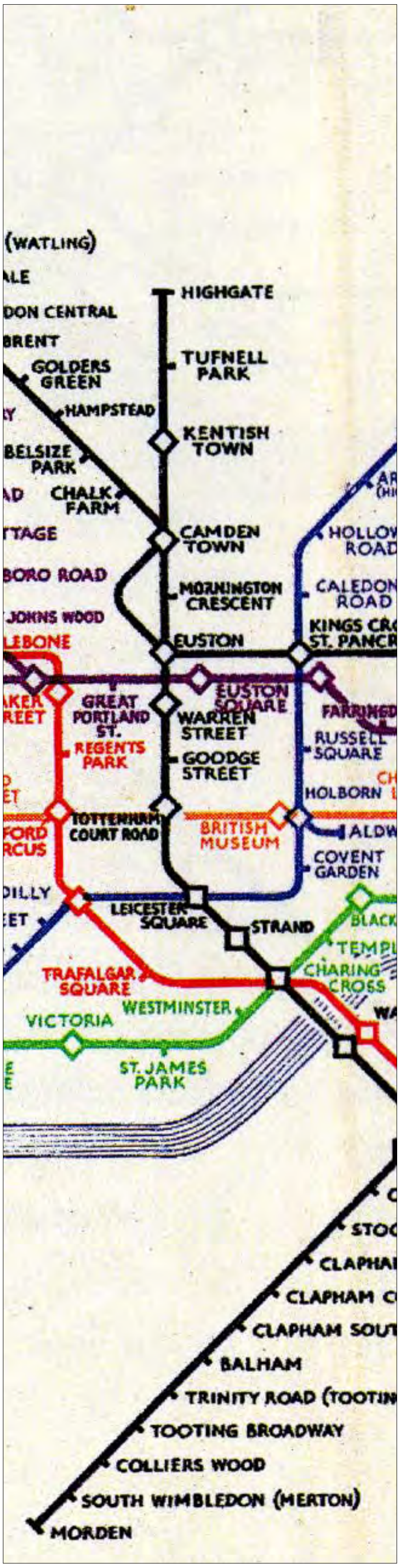
Second, the map capitalizes on the fact that the system operates underground and therefore the commuters need not be burdened with the confusing topography above ground. The only surface feature to survive was the River Thames. The map makes complex information simple by eliminating all extraneous details (Rajamanickam, 2005).

But according to Roberts (2005), Beck's main achievement was to select a particular set of rules, and employ them in a particularly ingenious way to produce an attractive usable map of a very complicated network at his first attempt. In fact, what links Beck's different map versions and later ones is a systematic approach to defined design principles. These all reflect Beck's intention to make the centre of the map clearer without making the overall design impossibly large, and to simplify planning a journey by removing what he perceived to be extraneous detail.

Beck drew the network of lines so that they were topologically faithful to reality - that is, maintaining their intersections –but with their geographical relationships distorted. The central section is where most people begin or end a journey, or where they are most likely to change trains, and where stations are closest together. This was therefore enlarged at the expensed of the suburbs, whose station distances are usually greater than in the centre. These changes have the often noted side-effect of making the suburbs appear to be closer to the centre than they really are, thus encouraging potential commuters to believe that journeys will be short. They also have the side-effect of suggesting greater distances than is actually the case in the centre, perhaps causing people to take the Underground when walking or taking a bus would not be much slower. Street details were also removed (Roberts, 2005).

Roberts (ibid.) argues that most of Beck's design rules, such as geographical distortion, smoothing of lines, colored lines, lack of street details, tick- marks for stations, surprisingly modern looking interchange symbols, minimizing numbers of curves, and use of only certain angles, can all be found on previous designs for London railway maps, although not altogether.

Perhaps Beck's major innovation, rarely used previously when showing an entire network, was to use 45 degree diagonals only; very restrictive, but paying dividends of visual simplicity if executed well.



Detail of H. Beck Diagram 1933

This innovation comes along with another Beck's achievement: implementing a diagrammatic Underground map, which could result in a clear compact design, so could be printed in a portable folder.

Most of the rules established by Beck have been enduring, although these varied to a surprising degree during his tenure. Roberts identify the following rules:

• Only horizontal, vertical, and 45-degree lines are used (although in 1941 60-degree diagonals were investigated).

• The centre of the map is enlarged but at the expense of the suburbs. Other geographical distortions may also be permissible, but may be frowned upon for example reversing the north-south relationship of a pair of stations on different lines.

Beck's 60° line diagram. 1941

• A distinctive interchange symbol is used. It is not possible to be more specific than this. Beck used at least five different conventions during his tenure, and only in 1964 was today's convention broadly established.

• Stations are denoted by tickmarks. In fact, Beck originally intended to use the more traditional 'blobs'. Tickmarks were such an improvement over these that blobs were never used again for the Underground map, indeed it is surprising that any designer of diagrammatic maps uses them today, especially where space is short.

• Lines are denoted by distinctive colors (although monochrome was used on early wartime maps, and, as we will see, to this day the difference between a 'line' and a 'service' has never been clear).

• Street details are not shown.

Main Design Issues

Having putted together a set of design rules and principles, Beck's next task was to refine and develop the representation of the Underground network working—within these restrictions. However the task was not as simple, especially considering Beck lack of cartographic knowledge.

Among the main design issues Beck had to resolve were:

• Dense Stations in The Central Area

The most obvious problem is that there are many stations densely concentrated in Central London. On today's map, only inside the Circle Line rectangle which -comprehend approximately an area of 9 kms by 5kms- there are 71 separately-named stations. The centre of the map must be expanded in relation to the suburbs so that it is legible, but then sufficirent room must be left so that the suburbs can be fitted around the centre without being difficult to read, or appering overly compressed.

• The Circle Line

Although its name suggests a regular form, its real shape differ substantially of a circle. Controlling the form of this line has been a challenge for all mapmaker involved in the design o the diagram. According to Roberts only Beck has ever managed a perfectly regular shape on a card folder

• Long Station Names

As usually happen in many maps very long names has to be place in an awkward spot (i.e. 'Tottenham Court Road"). This situation can implies the alteration of important parts of whole system.

• The Need for (45°) Diagonals

Diagonal lines on a diagrammatic map look very effective. However they are tricky and hard to manage, space consuming (reducing the options and space for placing names) and in general very unpractical. Diagonals are fare more sensitive to minor changes than horizontal and vertical lines. One small change in the system can require a redesign of an entire part of the map. Considering an expanding network such as the London underground (with numerous diagonals) this can signified enormous amount of work

• No Clear Interchange Convention

Interchange used to be a change of lines permitted without the need to pay an additional fare. The introduction of tickets that allows to travel unlimited times within a zone or zones- the concept has blurred its meaning. According to Roberts the decision of which station is or not an interchange has become arbitrary and dependent on the map designer. Another aspect that is still pendent regards with the distance between interchanges.

• The Need to Incorporate Additional Lines

The need to make space for extensions and new lines should be a source of much challenge and excitement to the designer. However - as it will be review later- Beck's principles constrains design alternatives complicating the incorporation of new lines. Today's version of the London network by the year 2016 shows how the complexity of the system will stress these principles

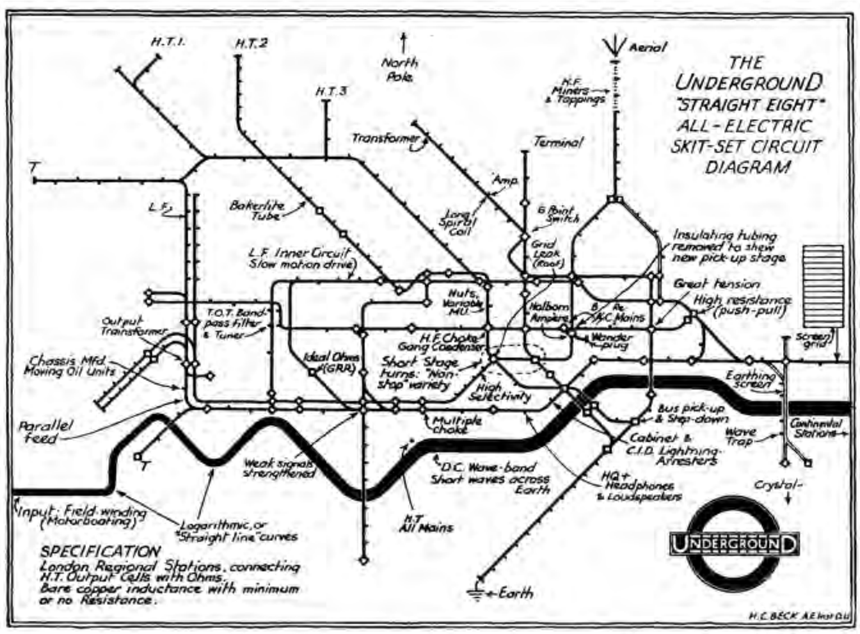
The Diagram as an Electric Circuit

Although Beck is usually credit for inventing the principles for diagrammatic maps for transportation, it is far from clear that he did. He probably was one of the first person to include a significant proportion of the Underground network on a single diagram, but in fact, color-coded maps with geographical distortion, even static spacing, regularization of shapes, and no street details, predate Beck's work by many years.

The idea that Beck was inspired by circuit diagrams has become a common place (Design Museum UK, 2006, Transport for London, 2008). Even the official website of Transport for London mention that Beck "based the map on the circuit diagrams he drew for his day job, stripping the sprawling Tube network down to basics". The idea probably expanded from a 1933's version of the underground diagram in which Beck replaced the names of the stations with electrical references. But, as Garland explains, this version was done as an ironic response to some colleagues that made fun of his work comparing the diagram with an electrical circuit (Garland, 1994). Although it would not be strange Beck was familiar with this kind of graphics, Roberts (2005) suggest that is more likely his inspiration came from other innovative schematic maps already used in some London trams.

No matter where the idea come from, it seems paradoxical that in the same year that Beck diagram was introduced to the public, the London Underground allow the London electricity board to install cables along its tunnels. According to designer critic Paul Elliman (2006) "even if Beck's map had never existed, a version could have been drawn up simply to chart London's electrical energy". For Elliman (ibid.) the relation of both networks symbolize –like Fritz Lang's film "Metropolis" (1929)-the utopian idea of efficiency and standardization: the city as machine metaphor.

The London Underground Diagram as a electic circuit done by Beck for the *Train, Omnibus and Tram Staff Magazine*. 1933.



The Diagram as a Modern Image of the City

The diagram similarity with an electrical circuit board was also consistent with an urban vocabulary of reticular terms such as circuit, circulation, grid and network – terms that have helped to idealize certain perceptions of the modern city (Elliman, ibid.). In his essay "the history of the grid" Williamson discuss the central role played by the grid in the development and consolidation of the modern movement in twentieth-century graphic design.

Although the symbolic aspect of the modern grid is not general recognized or even suspected -because it is rarely visible in the finished design- its use during this period as a compositional design matrix for controlling the placement of typography and imagery become essential.

According to Williamson (1989):

By the second decade of the twentieth century, the full development of the Cartesian grid was realized. The architectonic and constructive values so central to the early twentieth-century modernist canon were inherited from the preceding century. Viollet-le-Duc's or Joseph Paxton's promotion of exposed iron structure in buildings, Christopher Dresser's functional Arts and Crafts design of teapot handles based on bird and fish skeletons, or art nouveau's rejection of the applied surface decoration of Victorian design were all nineteenth- century expressions of this exodus from a belief in surface appearance as an esthetic end in itself.

It is therefore not surprising that an anti-individualist vision expressed itself in the entire spectrum of innovations which accompanied the use of the Cartesian grid in European graphic design in the late 1920s. The underlying, invisible matrix of the grid guided the placement not of manually produced letterforms or expressive gestures, but of clean and geometric sans serif typography. Horizontal and vertical *bars and rules were also used to subdivide the page space and corresponded to certain axes of the underlying grid.*

There are not evidence that Beck – an electrical draughtsman- acknowledged the symbolic and graphic connotation of the grid beyond its logical and practical compositional function in the design of the diagram. But as it is state by Hadlaw (2003)"reading" (and designing) the Underground map certainly relies on the possession of particular knowledge of modernity and urbanity. That is to say, the Underground riders of 1933 were able to understand the map not because they were versed in the shorthand of information design, but rather because both map and riders shared a common sensibility. It was comprehensible because the logic that underpinned it was coherent with their experience, as modern individuals, of an historically particular time and space.

For Hadlaw (ibid.) modern representations are complicit with modern ideals, and this fact has implications for the meaning of things. Beck's Underground map "is only a map after all": it identifies stations by name and proximate location, and it shows transfer points. It helps people get around. But it also is an ideal image of modern time and space: orderly, lucid, regular, efficient, and entirely functional. Lefebvre writes that capitalism has "produced abstract space, which includes the 'world of commodities,' its 'logic' and its world-wide strategies"—a space that is established on flows of capital, communications, and transportation. According to Hadlaw this might be Beck's real achievement: his map was so effective, and so easily comprehensible, because it acknowledged that new developments in transportation and communication rendered existing notions of time and space anachronistic. It acted to overlay everyday life with modernism's concept of space and time as malleable and serviceable.

As it has been discuss previously there is no doubt that Beck's diagram has had a deep impact on the way London is seen and on the way we see modern life (Forty, 1995). To this day it structures the locals' and the visitors' mental map of London (Vertesi 2008; Turnbull, 2007).

J. Vertesi (ibid.) expand this idea studying "the gap" between the iconic, abstract London underground map, and users' experiences and practices of navigating, experiencing and representing the city of London. Her research challenge official reports that insist that the Underground Map's iconic status is due to its exemplary design principles or its utility for journey planning underground. Using some of Lynch techniques, she presents results that suggest a different role for the familiar image: one of an essential visual technology (the map) that stands as an interface between the city and its user, presenting and structuring the points of access and possibilities for interaction within the urban space.

According to Vertesi the "Tube Map presents a fascinating case where the mediating technology in question is, effectively, the image itself. The map is interface not only to the subway system, but also, metonymically, to the city, establishing a virtual space in which the analog urban environment can be explored, constructed, narrated and understood (Vertesi, 2008)

The Diagram as an icon

The influence of Beck's diagram for the London Underground is not limited to the mapping of the subway system. The diagram has become the image of London, an unofficial trademark for its Underground (Mollerup, 2005), a design icon (BBC, 2006), the subject of multiple reinterpretations by graphic artists and advertisers, and "a seductive template for every kind of networks, from public transport to flow of electronic information"(Elliman, 2006).

Heavily copyrighted and controlled by branding regulations, the Underground map is an important marketing resource for London Transport. Its design has been used for all kind of tourist souvenirs and the graphic motive for T-shirts, umbrellas, lighters, postcards, clothing, and a variety of other items (Mclaren, 1926). An internal marketing and planning report (2004) estimated 95% of Londoners are said to have a copy of it at home. However the diagram symbolic ambivalence also induce to errors:

The Underground Diagram as a souvenir. Tea Cup

Vertesi mention the case of a widespread advertising campaign launched in 2003 by London Underground Limited aimed to establish a strong connection between the subway system and London. Londoners responded positively to the 'Love London' ads, but a post-advertisement survey was puzzled to find that only 30% thought that the ads were meant to encourage use of the system: the majority of those surveyed did not know what the ads were for. For them, the ad simply stated the obvious. The same survey also found that Londoners overwhelmingly responded that they 'Could not imagine London without the Underground', Unlocking London 2004 (Vertesi, 2008).

Many publications and cultural institutions have entitled the London diagram as a "design icon" or a "classic of twenty century design" ("Design Classics" The London Underground Map, BBC, 1987). On a recent BBC audience vote (2006), the Underground map came second on popularity after the Concorde. Roberts (2008) ironically comment that before considering the diagram as an icon it would be better to know which version are they considering given that it has changed substantially since it was first published, with good designs and awful designs. Even Beck's versions of the diagram differ between each other.

The London Underground map has also been the subject of numerous piece of art. For example in the controversial 1997 Royal Academy Sensation exhibition artist Simon Patterson took the tube map but changes the names of stations to artists, footballers, newsreaders, comedians, philosophers, saints, etc. The Great Bear, as it was entitle, offered the opportunity to travel the famous names of history and popular culture, passing a succession of comedians on the way to a philosopher. The diagram became a metaphor for the connectedness of persons; suggesting new relationships between them, parallel readings, other ways of configuring the data which govern our lives (BBC-h2g2, 2002) (Glancey, 2008).

Although the "iconicity" of the Underground diagram can be considered one of its main assets it can also become one of its main design limitation. It seems that its form has become an end in itself; forcing mapmakers to compromise its navigational function for its "classic" design principles.

Alternative solutions

Although its popularity, the design solution created by Beck seems to presents some inherent problems.

Critics have protested that Beck's Diagram was an inaccurate and misleading guide to London's complex configuration; some where even suspicious of its real purpose, hinting that it might be part of a devious plot to fool a gullible public into thinking the remoter stations on the Underground were more accessible than in fact they were (Garland, 1994).

Although Garland (ibid.) argues that Londoners knew they were not under any illusion about the city' real nature, the map telescoped scale brought the suburbs closer to central London stimulating the exodus of London's inner-city inhabitants. As nearly half a million people were entice out to the suburbs, where they found themselves captive customers of their local tube station (Rajamanickam, 2005).

The disproportionate spacing between stations is still misleading underground users today, encouraging them to take a train between two stations when other forms of transport would be far more suitable. The most famous case is that of Covent Garden and Leicester Square stations- not more than two hundred meters apart in reality, but well spaced on the Beck map.

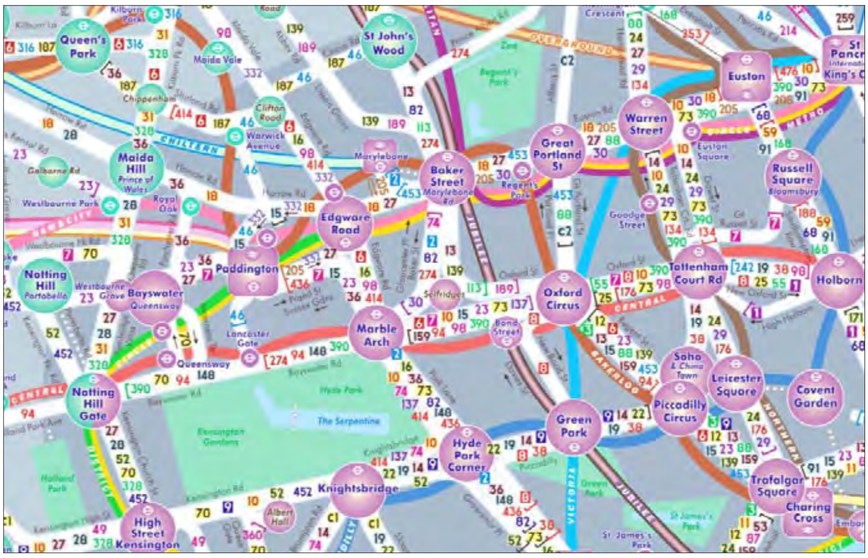
Alternative version of the London Underground Diagram. Students from Delf University of Technology led by Paul Mijkseenar. 1980-01

In 1980/81 during a design exercise with Beck's map, students from Delf University of Technology led by Paul Mijkseenar looked at this issue analyzing the difficulties passengers had in using the map when they had to change lines more than twice. An example of those problems has to do with two stations which according to the Underground map are 45 minutes apart (assuming that as a rule the traveling time between stations is three minutes). In fact, these two stations are within a five-minute walking distance from each other. According to Mijksenaar (1997 & 1999) there are evidently cases where the system map is misleading when planning a trip. The reason for this is that Beck's map is only intended to show functional relationships and has no intention to show geographically correct relationships. There are, however, elements in the design of the map suggesting a certain degree of geographically correct representation. As a consequence, passengers tend to use the functional and diagrammatical system map as a map also showing geographic relationships. In fact- according to Mijksenaar- to plan a trip properly a traveler also needs a street map.

Delft students, combining the both representations (diagrammatic and geographic), developed an alternative map. In the metropolitan area all lines are represented topographically correct so that important above-ground landmarks such as parks, main streets and museums could be added (Roberts, 2005). Mijsenaar explain that in this way a trip can be planned more efficiently, and alternative ways of transport, such as walking, can be considered. Outside the metropolitan area the lines are represented even more schematically than in the original diagram because here only the linear or functional relationship between the lines is important.

The Delft version accepts that the underground map is divided into two areas, the inner centre and the outer regions and that each has a different purpose: the inner to allow users to navigate around the centre of London; the outer to get users successfully in and out of London. So the map hit on a simple but effective compromise. The outer area was drawn diagrammatically, whilst the inner area was drawn topographically.

Another problem attribute to Beck's model is its limitation to adapt and support more information about services and the system in general. For example, as part of an integrated transport system the diagram does not provide useful information such as connection with buses. In response to this issue "Quick Map" -produce by an independent map publisher- proposed a radical approach to the map, departing completely from Beck's diagrammatic principles. Paradoxically, quoting one of Beck's most famous statement -"after all, the important things are the connections"- their "all-on-one" map depart from the orthogonal grid focus in the strategic role of nodes.

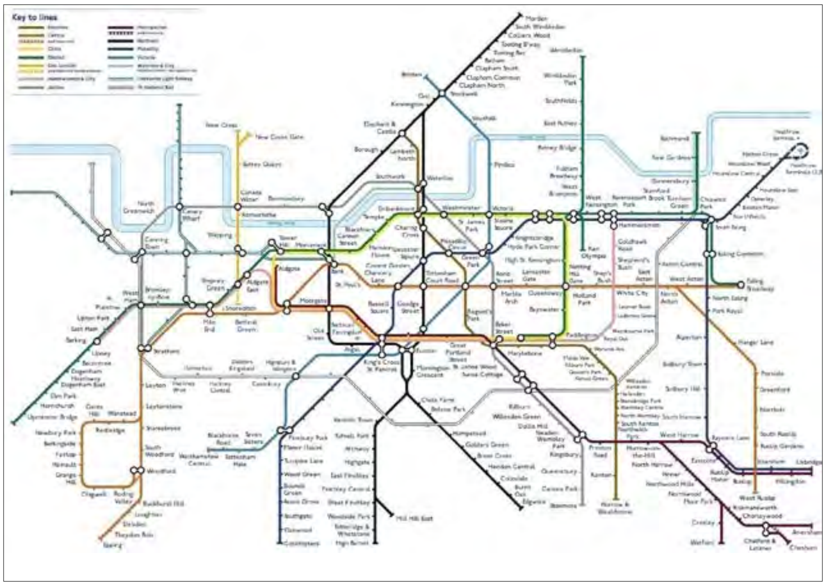


Quick Map "All in One" alternative to the London Diagram. 2008

Unlike the tube map the all-on-one is overground or surface map based on today's centres of activity in London ("nodes"), which are connected by bus routes and rail/underground links. Thus the map is much more realistic about the true geography of London although it still expand the central area where the density of people and activity are the highest. According to their promotional website (2008) QuickMap take a user or traveller's view rather than an operator's view such as Trasnport for London. This independence allows us to integrate the transport pattern more easily than worrying about corporate objectives of separate identities for the tube etc. "You and I just want to get there and get home again!"

However, Quickmap "all-on one" is a larger map than a TfL tube map, with more information that is more time consuming for the novice user to consult. Another problem seems to be that it only covers zones 1-3 what make it useful for tourist, but not necessarily suitable for Londoners.

During the last years a proliferation of independents maps have attempted to solve these and other problems of the diagram. Taking advantage of the numerous thematic websites and virtual communities dedicate to the London diagram, some of these maps have pointed out some weakness of the current version. Particularly interesting are the cases presented in Geoff Marshall's website (www.geofftech.co.uk), which presents a series of maps -based on the official diagram- that consider walk maps, distance map, upside-down maps and other creative alternatives.



Up side Down Diagram. One of the several design variation found at Geofftech's Silly Tube Maps.

While the Transport for London has ignored and banned most of these "bottom-up" proposals it is interesting though to see how the institution has moved with the times introducing, for example, interactive journey planners which inform the user of traveling times and better ways of moving between two stations (e.g. walking). However, this is an Internet based service, which isn't that useful for the traveller on the ground (Roberts, 2005).

Today's diagram design

Becks' fundamental design rules are still used in today's underground diagram and any decision to abandon or modify them would not be taken lightly. However the evolution of the London diagram clearly shows how its design has been reinterpreted both, by its inventor and subsequent designers.

The progressive addition of lines and stations in the last two decades, along some managerial decisions has complicated the representation of the underground network and as consequence the diagram has become more complex. A growing number of critiques have arisen complaining for its deterioration since the 1990's (Roberts, 2008)

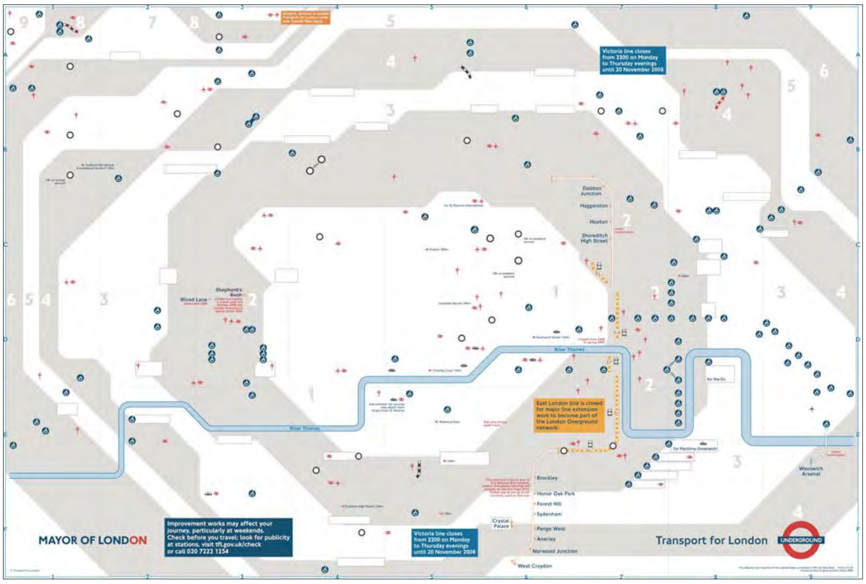
London Underground Diagram, *Tube Map*. 2008

In his recent article Information Pollution on the Underground Map (2008), Roberts argues how the "disproportionately" amount of information and its poor quality have increased users' cognitive load, so jeopardizing their interaction with the system. Among the main causes he described are:

• **Inconsistent Information:** The same symbol or style should have the same meaning wherever it is used. The same caveat should be flagged and explained in the same way wherever it occurs.

• **Incomplete Information:** When information is inadequately explained, this will lead to ambiguity. A user must either try to entertain all possible interpretations (increases cognitive load) or choose one (leads to incorrect decisions if the wrong one is chosen). The user must seek additional information elsewhere in order to make full use of what is provided.

• **Incongruous information:** People have expectations about the meanings of symbols and styles. The meaning selected by the designer should be compatible with the expectations of the users. Inconsistent information will result in incongruity



March 2008 Underground map showing everything that has been added over stations, lines and opportunities for changing between.

by definition, because one application will generate an expectation that is not matched by another.

Roberts (ibid.) uses the last versions of the Underground diagram to presents several examples of poor quality information design such as the warning dagger (thoughtlessly, inconsistently, or incorrectly applied), the inconsistent use of "Pecking" Lines, the introduction of new symbols in interchange stations such as Aircrafts (representing interchange with National Rail services to airports, but not which one), etc.

Another case he discuss look at the introduction in 2005 of zonal information in the map background, which according to him has not been cost-free in terms of usability. Its application in the current map is extremely clumsy, making lines harder to follow and stations harder to identify. When printed with too dark a tint, they result in uncomfortable stripy effects, when printed too light; it can be difficult to identify which zone a station is in. Even if the information itself can be relevant, its current means of application has undoubtedly polluted the map.

Probably one of the most controversial interventions in the diagram though, has been the addition of wheelchair blobs since the 2006 version. According to Roberts the problem with this symbol – that denote step-free access from the street to the platform- is that its application is simplistic and misleading. (wheelchair users should not be relying on the standard underground map under any circumstance) Among the reasons supporting this argument he mention:

• Wheelchair blobs denote step-free access from street to platform. They say nothing about from platform to train. Many stations currently involve a step at this point.

• Many stations have multiple entrances, often in different locations, several hundred meters apart. The standard Underground map gives no clues as to which particular entrances offer step-free access.

• Step-free interchanges are not shown (nor could they be), so that only a tiny proportion of the available journey opportunities are hinted at.

London Underground Diagram (Detail), 2008.

• Wheelchair blobs are jeopardizing the consistency and meaning of station symbols. Now there are four types of station, but only three different ways of showing them:

- *Tickmark:* A non-interchange station without step-free access.
- *Circle(s):* An interchange station without step-free access.
- *Wheelchair:* A station with step-free access that may or may not be an interchange.

Roberts discuss that having one important symbol obliterated by another is particularly poor information design. Either interchange circles are important, then they should always be shown, or they are not important, and so they should never be shown.

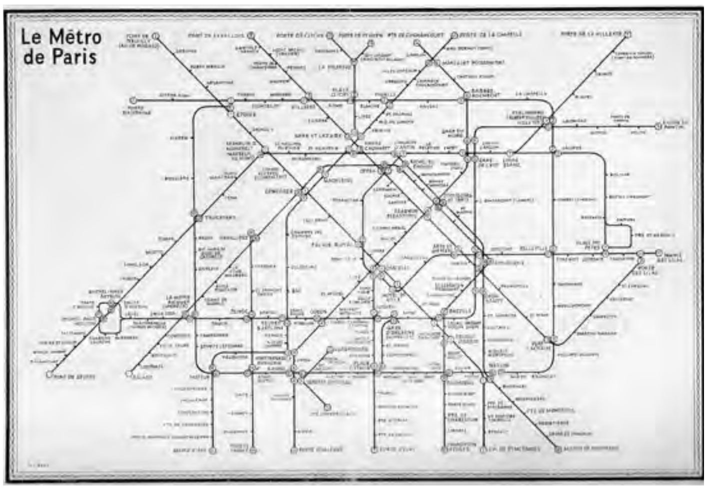
• Roberts finally ague that, although these interventions have all follows Beck's rules, have jeopardized the utility (clarity) and integrity (identity) of the diagram.

There seems to be an assumption made by many people that all a designer has to do is create a map using the same sorts of rules that Henry Beck did 75 years ago, and a design masterpiece will magically appear. This is not remotely true, and even if the geometry of the map is impeccable, serious usability damage will result if excessive poor quality information is added (Roberts, 2005).

The Diagram as a Model

Apart of the emerging criticism to today's diagram, the 1933's version of the Underground diagram changes the way we look at transport maps forever (Ovenden, 2005). Major transport systems (no only subways) around the world have adopted Harry Beck's principles with different results and its rationality and simplicity still fascinate many designers, scholars and transport users. As it was revised before, most literature available on this subject have contributed to perpetuate this "paradigmatic" model.

However, there is not such a standard for designing Public Transport Maps. The London diagram respond to many different variables and Beck was the first one in understands this, recognizing that his systems could not be applied as universal principle in other context. In fact some years after the publication of his first diagram he was invited to submit a design for the Paris Metro. After some days in France he concluded that his solution for London would not fit for Paris (Garland, 1994). The Paris Metro - the third- most complex system in the world at that time - was relatively compact with evenly spaced stations. Here, semi-diagrammatic- maps worked well-enough for there to be no need to move beyond this (Roberts, 2005).



H. Beck's attempt to represent Paris' Metro network with his schematic principles. 1946

As demonstrated in Mark Ovenden's book Metro Maps of the World (2005) the difference between Public Transport Maps are not just in general features such as typeface and line thickness, but in station and interchange symbols, angles and numbers of angles, and also the extent to which there is geographical distortion; surface details are shown; services are shown individually or grouped into lines, etc.

According to Roberts the conventions adopted by the London Underground map are but one way of presenting information, but is this way correct? This is difficult to answer, but it would be presumptuous to decide that the designers of the London Underground map are right, and the producers of all other maps in the world are wrong. On the other hand, it is difficult to draw any conclusions without comparing this case with other maps.

2.3 CASE 2: NEW YORK SUBWAY MAP

New York is today one of the largest and most complex transit systems in the world (Hertz in Hogarty, 2007). The 5,000-square-mile region served by the Metropolitan Transportation Authority (MTA) since 1968 has always depended on a network of transportation routes and systems for its vitality and development. This vast territory, centered on Manhattan Island and New York Harbor, was first tied together – and defined as a region – by railroads and steamboat lines in the 1830s and 1840s. Ever since, New York City's growth has continued to depend on the ability to efficiently move increasingly large numbers of people within its own residential and commercial districts and from the urban core to outlying farms, towns, suburbs, and villages. As the city expanded, so did its commuter environs (New York Transit Museum, 2008).

IRT Map. New York. 1905

New York is distinguished from most American cities by its use of public transportation. According to the 2000 U.S. Census, New York City is the only locality in the United States where more than half of all households do not own a car (the figure is even higher in Manhattan, over 75%; nationally, a mere 8% of households do not own a car). About one in every three users of mass transit in the United States and two-thirds of the nation's rail riders live in New York City and its suburbs. Transportation truly is the metropolitan area's lifeline (New York Transit Museum, 2008).

Unlike most other subway networks worldwide, New York system is one of the few that not uses a traditional (Beck-like) diagrammatic representation of its underground network. Since 1940, when NY transport was finally unify from different owners and operators, the Metropolitan Transit Authority have experimented with various graphic styles, trying to converge its corporate identity on the map (Ovenden, 2005). It is precisely this process and the variety of styles experimented in its history that makes the New York subway map a useful case of study.

The unique complexity of representing New York's subway system

To understand the challenge of visually communicating New York's subway one must understand New York's unique geography and its street system, both of which have an impact on the mapping. New York graphic designer Eddie Jabbour (2008) argues there are four significant and conflicting aspects that make the New York City subway very unlikely to be design with just a diagrammatic or just a topographic format. These conflicting aspects are:

• Its history of three separate and competing subway systems that were poorly coordinated to work as a whole system. (The chaotic tangle of these three competing routes, as they meander and fight their way through the dense street plans of lower Manhattan, downtown Brooklyn, and Long Island City, is the most difficult aspect of the system to map clearly and accurately.)

• The narrow geography of its principal thoroughfare, Manhattan Island, which has 17 separate lines running up and down midtown alone.

• Its orthogonal (gridiron) street patterns in four boroughs with the "cut & cover" subway tunnels and elevated lines that follow these street patterns.

• A system with different services running in the same lines: local lines, then express, then back to local, etc.

Historical Evolution of the New York Map

New York subway system has been developed since 1904 onwards by three separate companies. Two were privately owned; the Interborough Rapid Transit Company, the IRT, and the Brooklyn Rapid Transit Company - and the third, under city control, the Independent Subway of 1932 (Ovenden, 2005).

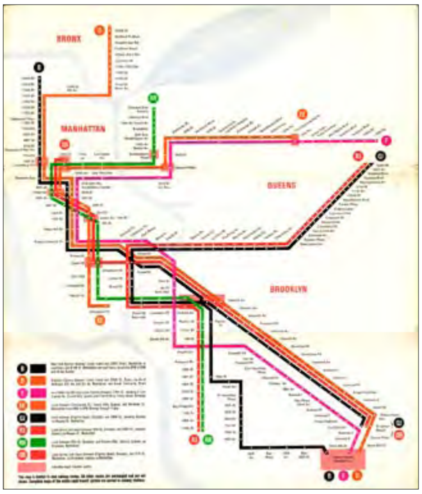
Although the system was integrated in 1940, until the 1950s each network issued its own map usually based on the geographic layout of lines. This operation was not really complicate since they only had to illustrate few routes. For example the IRT Map from 1905 depicts the ports and wharves along the edges of Manhattan. A complete street grid is visible, and there is even a scale, allowing riders to calculate the distances they were traveling. The map shows the subway routes as well as elevated trains that ran throughout the city (Popper, 2008).

The 1948 full color pocket map was one of the first attempts to show a unified network (Ovenden, 2005). Because no formal system emerged for renaming the routes, New Yorkers were left with a system where, for example, the Broadway Local, Seventh Avenue Line, West Side IRT and No. 1 all referred to the same train (Popper, 2008).

IRT Map. New York. 1948

In 1958 New York got its first schematic map, by George Salomon, which smoothed the edges of each borough, simplified train routes (bring them together), and eliminated geographic references such as Central Park. Among its peculiarities were the line designations and groupings, a mixture of alphabetic and numeric, the introduction of a modern sans serif type face such as Akzidenz Grotesque, some geographic distortion and 45 degree diagonals to simplify New York's complex service patterns.

This first schematic approach generates some problems among user particularly for eliminating color along with clutter. "Now we have a map that is a dull distorted gray mess," wrote rider Peter Rosenblatt to the New York Times in 1959. "The whole thing is a neat job of camouflage." (Popper, 2008) With some variation though, Salomon diagram remained the standard until the early 1970s (Ovenden, 2005).



In 1958 New York got its first schematic map, by George Salomon

In 1968, MTA commissioned Unimark International to design a sign system for the subways, and organize the navigational system that at the time was considered chaotic. Two Unimark designers, Bob Noorda and Massimo Vignelli, developed a signage plan based on a simple principle: "deliver the necessary information at the point of decision, never before, never after" (Bierut, 2004). Unimark rejected individualistic design and believed that design could be a system, a basic structure set up so that other people could implement it effectively. According to Meggs (2005) the basic tool for this effort was the grid, which standardizes all graphic communication independently the commitment. Objectivity was their goal as it spread a generic conformity across the face of multinational corporate communication. The design programs created by Unimark were rational and so rigorously systematized that they became virtually foolproof as long as the standards were maintained (ibid.). According to Heller, modularity mathematical precision and rationality informed every part of Unimark system for the New York subway. A couple of years later, Vignelli (now as a Vignelli Associated) introduced the same principles in the design of a new subway diagram.

Vignelli's Subway Maps

Vignelli and Associates' assignment consisted in design a map for the subway system that would simplify the web of lines on the existing one. Vignelli's original project in fact envisioned an interrelated system of four different maps:

- **A System Map:** only concerned with providing information from point A to B.

- **A Geographical Map:** Meant to provide more detailed information, including MTA stations, on a real topographical context.

- **A Neighborhood Map:** with the purpose of present information about the area.

- **A Verbal Map:** intended to described how to reach a destination, which train to get, where to change, and when to get out.

All these maps were suppose to be posted in the stations, so that complete information could be provided to the people using the subway. However only the System Map was implemented.

Looking at previous underground system maps such as the London Underground diagram, Vignelli, too, organized his subway map on a grid, orienting the "spaghetti work" of the existing railways to the verticals, horizontals and forty-five-degree angles of the page Each line had a different color, bright primary colors, and either a number or letter designation appearing at the beginning, at the end, and at intervals along the route. Every station was listed. Vignelli's main innovation was probably in the representation of the stations and interchanges. Every stop had a dot. A dot on the line indicated the train stopped at that station. "No dot, no stop" (Bierut 2004, Hustwit, 2007).

Another distinction with the London model regards the treatment of the background. Departing from the neutrality (emptiness) of the white (Vertesi, 2008), Vignelli's map introduced more geographical references. The web of lines of the New York subway lie over a white abstracted land masses, with the surrounding waters a mid-range gray, and parks designated with geometric forms in a darker shade of gray. The map was distorted, with the central, more congested areas larger and the outlying areas truncated (Heller, 2004).

Consistent with Unimark original guidelines, the map was settled in Helvetica, the emblematic sans serif typeface that epitomized the objectivity and functionalism of Swiss rational modernism. The typeface became part of New York's handwriting.

Vignellis' New York City subway guide was published in 1972 containing in one side the map with the entire system, and above this map its legend, which contains information about the service schedules of the different trains and formal definitions of the concepts used in the map. The reverse side of the guide provides a list of all the station stops for each of the trains in the system and more detailed information on service schedules and transfer points.

According to design critic Michael Bieirut the result was a design solution of extraordinary graphic beauty. The map became part of the Museum of Modern Art's Design Collection and is usually present as a millestone of modern design. Yet Vignelli's map quickly ran into problems and was replaced in 1979 (Bierut, 2004).

Vignelli Map for the New York Subway. 1972

Vignelli's Map Problems

Heller (2004) suggests that institutional changes at the Transit Authority were among the causes of the map substitution. According to the author soon after the system map was put into effect, the official who originally commissioned the project to Vignelli and Associates retired. His replacement called for a new map criticizing the map for lacking reference to the natural geography. Although vigorous campaigning to retain the award- winning map eventually failed to convince this new official who, as Vignelli described, "had the knife by the handle."

Independently to its aesthetics qualities and other political (administrative) considerations the implementation of Vignelli's map was criticized mainly by riders, among other things for its inability to relate the underground world of the subway with the above-ground geography.

Almost as soon as Vignelli's map arrived at stations, people started complaining about its failure to describe the city's geography. Tourists were getting off the subway at the bottom of Central Park represented as a small square rather than a tall rectangle) and trying to stroll to the top, for example, expecting a 30-minute walk (Mindlin, 2006).

According to Bieirut (2004), a major problem was that Vignelli's logical system came into conflict with another, equally logical system: New York is set up as a strong grid system, with blocks being equal in width and length throughout most of the city. Different than London where Beck's diagram brought conceptual clarity to a senseless confusion of streets and neighborhoods that had no underlying order.

The New York orthogonal street grid introduced by the Commissioners' Plan in 1811 set out its own ordered system of streets and avenues that has become second nature to many New Yorkers (Bieirut, 2004). Locked into the precise definitions of this grid New Yorkers can relate with relative precision the location streets, blocks and landmarks. As a result, the geographical liberties that Vignelli took with the streets of New York were immediately noticeable (particularly in Manhattan), and many commuters became increasingly frustrated by (topological) inconsistencies such as the location of some stations and the imposition of geometry over geographic accuracy. The map defiantly ignored the city's geography: the Broadway line was shown crossing the Eighth Avenue line at 42nd Street (they actually cross at Columbus Circle); Bowling Green appeared above Rector Street (it's below).

In a recent interview- commenting on his map- Vignelli acknowledged: "I just realize that maybe I possible make a mistake by indicating somehow the form of some areas (Manhattan, Queens, Brooklyn...) I probably should done what it was done in London, not to have an indication of the geography so a complete blanc, like beige or white background so that there is no suggestion of geography whatsoever. One of the problem that New York is that people couldn't relate geography with the stations and with lines and they were confuse by that. But they shouldn't. There are geographic maps, neighborhood maps in the subway so there is no reason why this geography has to be literal. It could be completely abstract. But I think I could done it better if I push the envelope even further and not have anything in the background and just gave them the lines and the stops. Maybe that point would be better. Otherwise it is perfect! (Vignelli interviewed in Hustwit, 2007).

Most of the design discussion regarding the failure of Vignelli's map has concentrated only in how it overstepped the acceptable limits of distortion of the city (Mijksenaar 1997 & 1999; Bierut 2004, Hustwit, 2007). Paradoxically Vignellis' geometric representation of geography is not much different than other previous Salomon's subway maps, such as 1959 version.

Further than its geographic distortion the conflicts with Vignelli's map also involved other perceptive and navigational issues concerning users difficulties to interpret symbols and key graphic operations introduced by Vignelli such as stations dots and interchanges.

In November of 1975, public dissatisfaction with the Vignelli's map prompted the NY City Transit Authority to organize a committee under chairman John Tauranac to study the problem of designing a right and proper map.

Among the experts invited in this committee was Dr Arline Bronzaft an environmental psychologist who in 1976 co-authored a study entitled Spatial orientation in a subway system with Dr Stephen B. Dobrow, and T.J. O'Hanlon.

Spatial Orientation in a Subway System

The aim of this research was to analyze the nature of the orientational problems of New York City subway user and to evaluate the adequacy of the Vignelli's map (New York City subway guide) as an aid in this orientation. The study evaluates how twenty users, new to New York City, travel through the subway system using the map. Users were assigned with a a route that considered a list of stations they were to travel to, and log sheets on which they were instructed to write down all the trains traveled and the times they boarded and left each train. They were also asked to write down other relevant material about their subway trips.

According to the test, Vignelli's map was directly related with almost one-third of the mistakes in all planned trips. Among the main errors committed by users were plan to use non-existent transfer, plan to use non operating train, failure to go to assigned station, disorientation because of inadequate graphics, and plan to use non-scheduled station stop, among others.

In fact none of the users evaluated was able to plan "acceptable" solutions for all the trip-segments tested, and only three out of twenty planned "acceptable" solutions for three of the four trip-segments. Only 46% of the trip-segments were traveled via "acceptable" solutions.

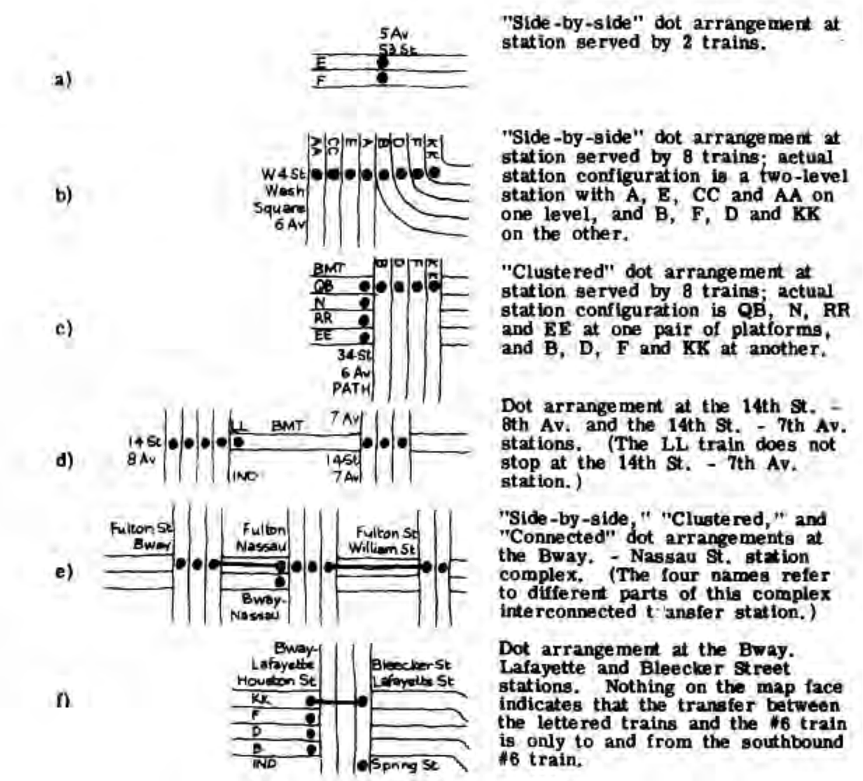
Two of the major problems established by the study had to do with legend and transfer points.

• **Problem with the legend of the Map or the reverse side of the guide:**
The study reveal a tendency for the readers of the map to ignore those portions of the guide that provide necessary information about how to use the guide as well as information on service schedules and transfers leads one to concluding that new methods for displaying such information should be devised.

• **Problem with transfer points**
Vignelli introduced dots within the lines to indicate station stops and clusters of dots or dots connected by thin black lines to indicate transfers between trains. These operations were meant to correct a major problem with the 1968 version that used "boxes" to indicated stations. For Vignelli these "boxes" interrupted the movement of the eye along the line of each route. (New York Times, 1972).

Since many users did not read the legend on the top of the map that defined transfer points, they failed to obtain relevant information regarding the meaning of dots- either side-by-side, clustered, or connected by a thin black line (on transfer points). Furthermore, according to the study, the entire method of indicating stations and transfer points by dots was the most confusing to the users. For one reason, the thin lines joining some of the dots were hardly visible because they were obscured by the color lines indicating routes and the grid squares on the map. Second, a large cluster of dots represented subway stations serviced by many routes that transferred. Users could not decide whether desired transfer could be made because such a large cluster confused them. Third, users could not always determine whether or not station dots were close enough to be considered a cluster. Although the experimenters did not conclude from their findings that the "dot" feature of the map should be eliminated, they indicate the "dot" feature was a major source of confusion, particularly at transfer points (Bronzaft et al., 1976).

Bronzaft sketches illustrating conflicting points in train transfers in the 1972 Subway Map.



These scientific evidences do not seems to be acknowledged neither by Vignelli not by design literature as critical issues in the map. However in a recent updated edition of the Map, Vignelli improved substantially the legibility of transfer points. Paradoxically he kept the contours of geography in lighter tones but removed the polemic "square" representing the Central Park.

The MTA finally decided to commissioned a new map which was to re-introduce the study recommendation and other New York key references (i.e. streets)

In fairness it must be consigned that Vignelli's original project was not completely implemented by the MTA but at this point it seem meaningless to speculate about this issue. Vignelli's map was as close as New York came to the schematic simplicity of London's Underground diagram.

Vignelli's Rational Modernism

Although Vignelli's diagram basically followed the same principles and the logical rationality behind the London's diagram it can be argue that its design also responded to a different context and ideological conditions. Vignellis objectivity and neutrality toward the designing information reflect his inflexible commitment to the foundational principles of graphic modernism, also known as the Swiss Style. (Hollis, 2006).

According to Heller (2004), Vignelli's training as an architect in Italy in the mid-1950s and his study with the Swiss graphic designer Max Huber made him a veteran of the grid. Since then Vignelli has been a passionate protagonist of rational design theory -especially in the United State- and is known among other things for being a steady promoter of "Swiss" modernism as a typographic method with universal validity (Lupton 1996, Hollis, 2006).

As graphic designer Katherine McCoy (2007) explains, the assumption of modernist rational "Swiss" method – a codified approach not so dependent on the individualistic inspiration and talent of the designer had a profound professional influence in American graphic design. This method - she argues - prescribed an ordered process rather than the genius of inspiration, and promised far more dependable, however predictable, results. It assumed a rational systems process based on semi-scientific analysis and problem solving. The ideal was the objective presentation of information, rather than the subjective expression of an attitude, emotion, or humor. The "Swiss" graphic expression stressed the syntactic grammar of graphic design with structured grids and typographic relationships.(ibid.).This same grammar enabled many a corporation and institutions at the time- such as the MTA- represent itself as being in some way beyond the messy reality of everyday concerns and problems (Kerry William Purcell, Eye Magazine No 51).

Semiotics as a scientific approach to the analysis of meaning in communication was also very compatible at the time with the rationality of the Swiss method. Promising an alternative to intuitive design, semiotic theory began to inform some of the "Swiss" adherents in the United States such as Vignelli. In fact as Heller (2004) recount, Vignelli's interest in the subject come from a long-lasting friendship with semiotician Umberto Eco.

"We were analyzing everything according to a semiotic grid. It was just natural for us, like the ABCs" remember Vignelli, who sees the semiotic grid as a relationship between semantics (the meaning of the information), syntactics (its visual representation), and pragmatics (the effect of the sign on the receiver). For Heller it's a closed-loop system to make sure a design dearly and consistently represents the proper message and that the audience receives that message as intended (Heller, 2004).

However McCoy discusses, that semiotics, as a difficult and complex theory, was little understood by designers at the time. According to her graphic designers appropriate semiotic to validate them intellectually: the "scientific" flavor reinforced the "objective" tone of "Swiss" design, and reinforced the idea that graphic design was more than a personal art form (McCoy, 2007).

According to Bieirut, Vignelli's map exemplified the essence of orthodox modernist principles. Paradoxically is during the 1970s that a number of graphic designers began to overthrow the conventions of modernist graphics and use the grid to new ends (Williamson, 1989). For many designers the case of Vignelli's diagram represents not only a turning point for the New York subway Map, but also for modern design (Heller 2004; Bieirut, 2004).

“The Map”

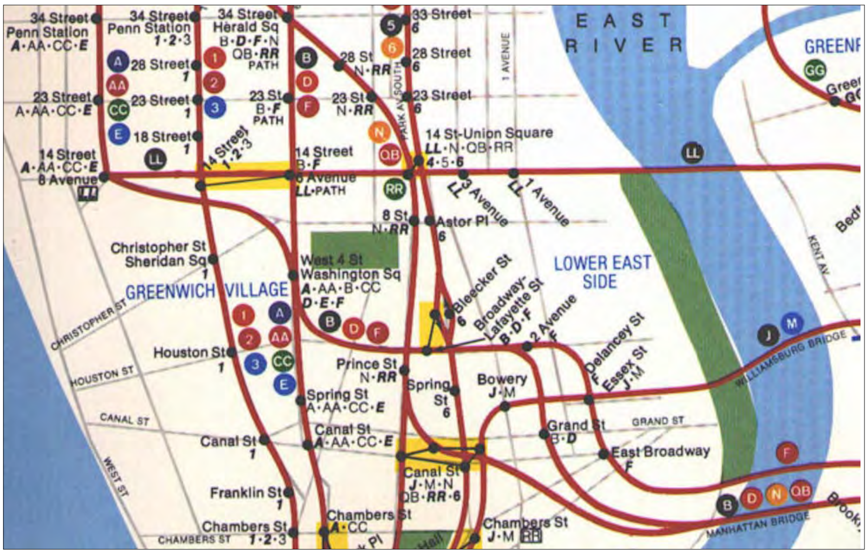
The current NY subway map varies only in detail from the one that Michael Hertz and the MTA presented to the public in 1979. Hertz was hired by the MTA to create a new map that incorporated a more realistic look, as well as more information about the city itself and its transportation system.

Official MTA New York Subway Map designed by Michael Hertz Assoc. 2007

Initially the biggest constraint for Hertz team was that it had to fit into the existing map frames in every subway car. Negative public response to the abstraction of the Vignelli map seems to have dictated that the new map be geographical in appearance. This meant that in order to make the most of the space available and therefore to make the map readable (since New York’s actual geography is taller and narrower) was to knead, bend and squeeze the map to fit in the already existing frame. Once Hertz did this he realized that he could nip and tuck smaller areas of the city to give more space to congested areas like lower Manhattan and downtown Brooklyn without major damage to the overall sense of the city’s geography. According to Hertz this has become a signature of the New York map’s design (Hertz in Hogarty, 2007).

Hertz's team though, did not arrive immediately at the final design. The 1979 map actually evolved as the third conceptual approach that was experimented as a response to dissatisfaction with the Vignelli map.

The first test came in 1976 using the atlas Seeing NY, the official MTA Travel Guide as a accurate scale map where Hertz drew all the routes on geographic basis (the other extreme of Vignelli's approach).The density of detail in this map could only work in a multi-page atlas format wherein the city is cut into many small segments. It certainly could not work in a (58.42 x 76.2 cms) subway car frame (which is proportioned differently from the geography of New York City) or even in a folding hand-held map; the amount of detail would have required a sheet of paper much too large to be handled and folded easily (Hertz in Hogarty, 2007).



Detail of 1978 MTA prototype map.

The 1978 test, used for testing still used Vignelli's eight colors to designate the route 'bullets' and a single color red for all the lines, The geographic detail was cut back with only operational and thoroughfare streets drawn, and the geography was modified to fit into the frames.

To Hertz dismay, when Dr. Arline Bronzaft scientifically tested this map, most of the respondents in their comments preferred and defended Vignelli's graphic approach. However the actual scores told something different; these respondents scored significantly higher in the practical task of finding one's way on 'paper trips' using the new map prototype (Hertz in Hogarty, 2007).

Based on the results of this testing, Hertz and his team went back and refined his design. For this map Hertz adopted a 'Trunk Line' color coding [one color for each avenue of operation in Manhattan] based on an the almost universal demand from the public for more colors to better delineate the routes. Hertz also made further targeted modifications to the geography, widening Manhattan and opening up lower Manhattan and downtown Brooklyn to eliminate the need for an enlarged inset of this area (in the 1978 map), while taking care to retain a relatively "correct" distance relationship between geographic points. The result was the final 1979 product that was printed and widely distributed as a stand-alone map serving almost intact as the conceptual basis for the current map with well over 100 million printed to date.

Hand drawn sketch for the 1979 design.

1979 subway map for wide release

The map that emerged in 1979, seven years after the publication of Mr. Vignelli's design, showed more geographical information than any previous New York subway map. It was the first since the 1930's to reproduce the street grid; it gave neighborhood names and pointed out major landmarks. Subsequent maps have imported even more geography, and added more information; in 1998, for example, the M.T.A. drew in pop-up balloons showing major bus connections. Since that year, the subway map has been officially known simply as "The Map" (Mindlin, 2006).

Detractors have complained about "The Map" overload of information. (Heller 2004, Bieirut 2004). For example Vignelli –one of the main critics- think "The Map" has been flowed with information, which is so difficult to retrieve that makes the whole point of the map equally useless (Hustwit, 2007).

In spite of these critics, Hertz argues that unlike most design projects, this map was designed and tested over the course of three years. It was reviewed internally at MTA and revised many times. Several options were considered and most of the major problems worked out before it hit the streets. (Hogarty, 2007) Perhaps for this reason "The Map" has endures almost immutable until today.

Alternatives "Images"

In a recent interview for the New York time John Tauranac- one of the ideologist behind todays' New York Subway map reminded that "one of the stormiest battles involving New York's self-image involved neither development nor political leadership, but what would seem the most mundane of issues: the look of the city's subway map" (Mindlin, 2006).

In fact until today the debate about the best way the New York subway system should be represented is still active. One example is Vignelli's recent updated version of his 1972 map for an special issue of Vogue magazine (Popper,2008). But probably the most intriguing and discussed alternative to the subway maps appeared in the last years is the Kick Map.

The Kick "Hybrid" Map

The Kick Map is a bottom-up initiative that introduces a compromise between Vignellis' and Hertz maps. Is designed with a combination of both diagrammatic and topographic features, thus enhancing the strengths and eliminating most of the weaknesses of both types (Jabbour, 2008).

On the top, a detail of Hertz official MTA map. On the right a detail of Eddie Jaoubur's "hybrid" Kick Map, an alternative design for the New York Subway

According to his author. – graphic designer Eddie Jaoubur- the Kick Map is a "hybrid" concept that resolves the 50-year debate between the exclusive use of either a diagrammatic or topographic mapping of the New York City Subway. Both map types have inherent strengths and weaknesses in their attempts to translate the maze of this complex system. Used alone, each makes the subway system very hard to understand for a surprising number of people (ibid).

One premise of the Kick "hybrid" map is that while most of the time a straight line seems to be the easiest line to understand, there are important exceptions.

The Kick Map employs "route bends" in a subway line's route to signal to the user important aboveground road changes. Unlike the Vignelli map - where the positions of the stations and lines are distorted, the Kick Map's stations are located accurately, in the correct position in relation to each other and to the topography above. The Kick Map also presents a comprehensive grid of major streets and avenues that intersect with all the station stops. This characteristic may support users orientation, improving the relation of a subway stop to the geography (streets) above it (ibid).

The hybrid concept irons out the "kinks" of any single street as it would in a diagram map. Unlike the current MTA-Hertz's map, a single road's "wiggles" are straightened and for clarity the Kick Map keeps to standardized angles whenever possible. The diagrammatic form allows a significant reduction in size- about two-thirds the size of the current one- but it does not present information about interchange with buses and other surface transport modes (ibid).

The kick map is still under developing and its access is limited, however its "hybrid" concept has already caught the attention of many New Yorkers and map designers (Corbett, 2007)

"The Map" Today.

Today's New York subway map is the key to understanding probably the most complex subway in the world (26 separate lines and 468 stations). It is hard to know to which extent today's official map characterized the image of New York, but it has certainly defined the way new Yorkers and visitors navigate through the city for almost 30 year. In a constantly changing city, it is impressive to realize that New Yorkers have had essentially the same subway map for such a period. In fact the current map varies only in detail from the one that Michael Hertz and the MTA presented to the public in 1979. This is probably one of its main virtues, the capacity to incorporate and adapt information avoiding drastic graphic changes.

2.4 TWO RELEVANT QUESTIONS.

The presentation of the London Underground diagram and the New York subway map has been intended to demonstrate that beyond its functionality - supporting travelers' navigation through the city- public transport maps are also symbolic communicational artifacts. Furthermore it attempts to evidence the complexity behind its design and the responsibility of mapmakers in identifying, interpreting and resolving the communicational differences between transport systems, users, and their context through graphic means.

The analysis of both cases also served to illustrate many of the issues involved in the representation of Public Transport Maps. For example:

- Preponderant role of designers in the conceptualization and creation of maps
- Maps as key component of transport system
- Maps as complex graphic devices
- Maps as an image of the city
- Maps as a representation of users needs and context
- Maps and user-center studies
- Hibrid Maps as a growing trend
- Importance of graphic symbolization and labeling
- Etc.

While many of these aspects are discuss through the next chapters of this thesis, it should be acknowledge that some issues -such as user evaluation of graphic symbols- exceed the scope of the present study and may require further multidisciplinary research.

Inferred by the cases of London and New York this thesis focus in two problematic issues that can be summarized in the following questions:

- **What Public Transport Maps Represent?**
- **How these Elements are Graphically Represented?**

Chapter 3 and 4 attempt to tackle the first question presenting aspect and elements that should be consider in the map. Chapters 5, 6 and 7 identified the design attributes and graphic characteristic of these elements and their organization in the plan.

In order to tackle these questions in a more inclusive manner a larger review of cases was considered necessary. The cases of New York and London have been complemented with several international maps compiled and analyzed according to these tasks.

Chapter 3
International Survey of Public Transport Maps

The Survey

As part of this study, a comprehensive survey of Public Transport Maps across the world has been contemplated. The survey (See Annex 3) is intended to obtain relevant information on which elements are most commonly depicted in this kind of maps and how they are graphically rendered worldwide.

Most of the samplers were obtained from official transport agencies' websites between the years 2007 and 2008. It considered one hundred and thirty-four (134) transport maps in eighty-six (86) cities in thirty-seven (37) countries in four (4) continents. It is primarily base on digital files (mainly in pdf format) equivalent to the printed version offer by transport system. Some printed samplers not available online were also considered.

The initial idea of the survey was to count with a broader perspective of international cases since most of the previous studies done on the subject usually considerer a limited number of samples and/or were prescript to European and North American cities. For example, Morrison's study (1996) analyzed the maps of 25 western European cities and Cain's survey (2007) only considered material from North American agencies (121 cases). From here the relevancy of the quantity and origin of the cases analyzed.
Nevertheless it is important to state that quantitative results were not the main result expected from the survey. Insteaad Among the aim of the survey were:

- **Itemize design elements usually represented in this kind of maps.**
- **Examine how these elements are graphically presented and organized within the map.** *Annex 1, Chapter 6 & 7*
- **Define a graphic inventory of symbols and fonts used.** *Annex 1 & Chapter 6*
- **Observe how similar representational conflicts are resolves by different mapmakers.** *Chapter 7*

Itemization of Map Elements and Features

One task -not registered in the survey- consisted in the identification of the most recurrent features and design elements present in the maps reviewed.
A non conclusive list of is resumed here:

Analysis of Maps' Graphic Elements

DESIGN ELEMENTS

- Titles
- Legends
- Instructions
- Scales
- Mapped areas
- North symbol
- Graticules
- Insets
- Borders
- Graticule
- Credits
- Advertising

LINE SYMBOLS

- **Modes**
  - Metro
  - Train
  - Bus
  - Tram
  - Taxi
  - Boat
  - Funicular
  - Bicycle
  - Pedestrian
  - Other
- **Routes service**
  - Regular
  - Express
  - Night
  - Temporal Service
  - Under construction
- **Landmarks**
  - Street & Avenues
  - Rivers, canals and creek
- **Directional Arrows**

POINT SYMBOLS

- **Transport Infraestructure**
  - Terminals
  - Interchange/Connections
  - Stations
  - Stop
  - Door opening
- **Landmarks**
  - Important buildings
  - Turisitic Attraction

AREA SYMBOLS

- **Natural/Geographic Landmarks:**
  - Lakes/Sea
  - Mountains
  - Woods
- **Large Artificial Landmarks**
  - Airports
  - Parks & Greene area
- **Areas/Limits**
  - District
  - Tariffication

LETTERING

- **Labels**
  - Route number
  - Station/ Terminal names
  - Street names
  - Landmark names
  - Neighbors, districts, etc.
- **Pictograms**
  - Transport mode
  - Information
  - Accessibility
  - Elevator
  - Parking
  - Toilet
  - Bicycle
  - Operator Bran

The instrument consider two main sections. Section 1 provide general information about the city, its transport system and some technical properties of the documents examined. Section 2 analyze the design aspects of the samplers (maps) according to three level (Structural, Graphic, Typographic) that are further developed in chapter 6. While the information of the Section 1 was obtained from different sources (mainly through information available in the official website of the transport system and through data encoded in the PDF files); the information in section 2 come directly from the analysis of each sampler. All the information was organize in a operative framework (Microsoft Excel) that facilitate the analysis and the comparison of information.

The graphic information of each sampler was categorize and computed according the following variables:

SECTION 1

City
- Population
- Area (km2)
- Country

Map
- Name of the Institution
- Name of the System
- Year of the Map
- Source (www)
- Transport Modes.

Document Properties
- Format (cms)
- Software:
- Designer/Authors

SECTION 2 (Design Levels)**

Structural Level
- Style (Morrison classification)*
  - Classic Style
  - French Style
- Fidelity/Abstractness
  - Cartographic
  - Hybrid
  - Schematic
- Fixed Angles (i.e. 0°/30°/45°/ 90°)

Graphic Level
- Point Symbols
  - Stop/Station Symbol †
  - Interchange Stations †
  - Landmarks †
- Line Symbols
  - Directionality †
  - N° of Color Lines
  - Street/Avenues
- Area Symbols
  - Background
    - Geographic Ref.
    - Politic
    - Tariffication
    - Arbitrary
  - Geographic References
    - Water
    - Land
    - Compass North

Typographic Level
- Fonts
- Station Label Orientation
- Route Labeling †
- Route Number Orientation
- Terminals*

* See Chapter 4
** See Chapter 6
† See Anex 1 & Chapter 6

Graphic Inventory of Maps Symbols

Base on the experience done by Bureau Mijksenaar (1995) for the Royal Dutch Transport (KNV) in the Netherlands (Uniforme beeldtaal openbaar vervoerplattegronden), most of the symbols used distinctively in Public Transport Maps (i.e. stations, route labels, terminals) have been typified and redraw in similar scale and color (grayscale) in order to facilitate the comparison of their morphological features (See Anex 1)

Relevancy of the Volume

Many examples of maps appear in this compilation (134 cases). According to different authors Slocum et al. (2004),Blackwell and Yuri Engelhardt (2001) it is particular important for those involved in the design of maps to build a mental inventory of designs and design possibilities. Borden Dent (1993) referred to this mental inventory as an image pool, which can be built by critically viewing as much art, graphic design, and-of course-maps as possible. Beside its investigative dimension the maps compiled in this survey also pretend to make a contribution in building an image pool of Public Transport Maps that could serve as a reference for different mapmakers and those interested in its study.

Chapter 4

What Public Transport Maps Represent

As it is evident in the cases of London and New York presented in chapter 2 Public Transport Maps not only represent the transport network but should represents graphically a variety of aspects of different complexity and diverse nature. In many cases the definition and manage of these aspects goes beyond designer's competency and are only evident if there is a familiarity with local conditions. From here, the need of mapmakers to work within interdisciplinary teams and local actors.

The different aspect that should be represented in the design of Public Transport Maps has been already suggested by Morrison, (1996), Kennedy, (1999), Avelar and Hurni, (2006), Avelar (2008) and can be characterize in: the representation of the transport system, map users, and its context.

4.1 TRANSPORT SYSTEM

The representation of the transport system is doubtless the first purpose and subject matter to be considered in a transport map. The analysis of the network and its characteristics certainly play a fundamental role in the selection and arrangement of design elements and its composition. These characteristics include the number of transport modes to be considered, the number of services at each transport mode, any predominance of one transport mode over others, the existence of overlap between routes, variances in routes, and distance between stops, etc. Other relevant types of information to keep in mind are the frequency of service, the fare system, and how often routes may change (Avelar, 2008).

Transport Mode

Transportation modes are an essential component of transport systems since they are the means by which mobility is supported. Geographers consider a wide range of modes that may be grouped into three broad categories based on the medium they exploit: land, water and air. Each mode has its own requirements and features, and is adapted to serve the specific demands of passenger traffic. This gives rise to marked differences in the ways the modes are deployed, utilized and represented in different parts of the world (Rodrigue, 2006).

With few exceptions (i.e. Venice) most Public Transport Maps represents land modes. In most cases, though, Public Transport Maps represent connections with airports and ports. The growing demand of aerial transportation within metropolitan areas– like helicopters in New York and Sao Paulo- may eventually require further representation in future maps. Recently some transport systems have begun to consider bicycle trails and pedestrian paths as a component of their networks, but their depictions in system maps are still rare and are commonly presented separately.

Among the most commonly represented modes in Public Transport Maps are:

- Urban Rail: Train/S-Ban /Underground/Metro/Subway/U-Ban
- Bus
- Trams
- Cable car
- Funicular
- Boat/Ferry

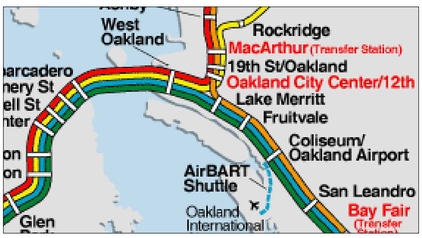
Of all Transport modes Urban Rails, Buses and Trams, are probably the most frequently display in maps. A report from the British Consultant Transport Research Laboratory (TRL 593, 2004) define this mode in the following terms:

• Urban Rail
This mode comprises underground and metro systems designed for high capacity, and fully segregated from surface traffic (such as those in London, New York and Paris). Station spacing tends to be somewhat greater than for tramway/light rail, and average trips to/from city centers. The degree of short-run substitution with other modes is often less than for bus or light rail.

• Buses
Buses are usually the largest element in public transport provision, being the most ubiquitous mode. A distinction may be drawn between "local" and "other" services. Local services are available to general public on demand (generally serving all stops along a route, with cash payment on board, or at stops, permitted). Other services include longer-distance scheduled services (such as intercity express coach) which are also available to the general public.

• Tramways and Light Rail
This mode includes traditional street tramways (i.e. Amsterdam), many of which have been expanded and upgraded through reserved track extensions and priority measures (i.e. Gothenburg). Entirely new systems have been developed from the 1970s, either largely segregated (i.e. Calgary) or reintroducing the street tramway in a more modern form (i.e. Nantes). Average trip length is generally short, and the role filled may be similar to that of buses, but with greater potential for attracting car users due to higher speeds and service quality. Wholly automated systems often fall within this category in terms of density and trip length.

Bus Services in Dundee. UK



Bart, San Francisco metro system. USA

Representation of Transport Modes

As it was demonstrated in the case of the New York Subway Map there is not a definitive way of representing Transport mode. Indeed there are many bus and tram maps designed as diagrams (i.e. Dundee) and many metro systems that have opted for a more cartographic approach (i.e. San Francisco).

However many mapmakers seem to have a propensity to depict modes according to their interaction with the urban environment. While underground and rail system are treated as "segregate" modes; buses, trams and light rails are usually regard as "surface" or "open" modes –therefore in direct relation with its surrounding.

• Segregate Modes

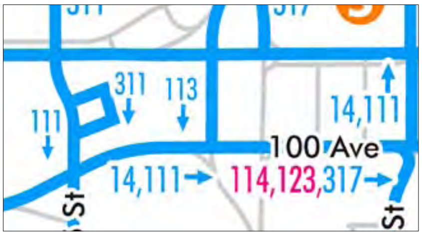
Underground, and rail services generally, lend themselves to a diagrammatic format. In order to plan a journey, passengers need only to locate the stations most accessible from their points of origin and destination, and presume a reasonable quality link between the two in terms of frequency and reliability. Information on where to change routes can be provided crudely but with clarity—an interchange symbol—because the discrete nature of the network limits the range of routing options. The cross-city nature of most urban railways seldom requires passengers to change more than once or twice (Horne, 1986).

According to Horne the diagram is a crude but powerfully designed 'journey planner', color coded by service group through key stations. There is an unstated requirement for passengers to travel to the next key junction and change there if in doubt or in the absence of a through train. Traveling within this coarsened system, the passenger has no intrinsic interest in the track alignment between stations (i.e. Vienna's Wienerlinien Der Pplan Der Sschnelisten Wege), because each station is itself a unique reference which can be clearly announced by station name boards and by reference to on-train publicity.

Vienna, Wienerlinien Der Plan Der Sschnelisten Wege. Austria.

• Surface Modes

Bus and trams services frequently operate in an adverse environment: on the streets amidst the clutter of other vehicles, other street furniture and with road and pavement layouts seldom designed specifically for buses –trams and their passengers. In many cities bus stops, unlike railway stations, are seldom displayed on street maps—passengers must head hopefully towards roads which might be used by buses (i.e Edmonton Day Map). Once in the immediate vicinity of a bus boarding point, it may not be clear even with a single pair of stops (one for each direction of travel), which stop to head for—the equivalent of finding the correct platform.



Edmonton, Day Map. Canada.

Identification of alighting 'stations' and interchanges, and the useful countdown process that many passengers on the Underground follow before alighting at the correct stop, is difficult on the buses without information to identify wayside locations clearly from the bus window. The bus passenger lacks uniquely identified stations and on-vehicle information, so may need to be interested in the geographical location of the bus at any point along the intended journey. And unlike the Underground passenger who can follow station 'way out' signing and check the local street nup of the catchment within a half-mile, the bus passenger alighting in an unfamiliar location lacks the on-site publicity to orientate himself in relation to the bus route just used and the catchment now accessible. The passenger frequently has to make recourse to bus staff and passers-by, because of the paucity of signing (not helped by the cluttered and haphazard layouts often found in the vicinity of bus stops).

In recent years there have been various developments with the aim of making bus services more attractive to passengers. These include bus priority schemes, designed to reduce bus journey times and make services more reliable by isolating buses from general traffic congestion. While some such schemes have been successful (i.e.: Transmilenio in Bogota, Colombia) others have achieved few benefit, often because of difficulties in circumventing physical obstacles where priority measures are most needed.

Guided bus schemes are a variation on conventional bus priority measures, imbuing bus services with some of the features of light rail systems (including more effective exclusion of non-priority traffic), but with the added advantage of greater flexibility at the ends of guideway sections. Low floor buses are becoming more common, enabling easier access to elderly and infirm passengers, parents with young children, as well as to wheelchair users. Off-bus ticketing systems are improving passenger convenience, and reducing boarding times, with benefits for journey times and service reliability. Bus location systems can contribute to bus priority measures, and to real time information system passengers.

All of these measures seem to dilute the differences between transport modes (i.e. confine vs. open) therefore, stressing its graphic representation in maps. Already in 1996 Alastair Morrison argued that the exact definition of a mode in public transport maps was somewhat arbitrary since -for example, two modes could be represented as one and one mode could be rendered in many services.

Morrison National Styles

French style: Tokyo, Metro

After several studies on the cartographic representation of transport services in European cities Morrison concludes that there are certain national differences between the styles of public transport maps. Based on this particular characteristics he identified and the following national styles:

• **French Style** *(used in France and in most cities of Switzerland and Belgium)*
One line for each service of a transport mode, each line in a different color; service numbers appear in general at the two route termini (i.e. Tokyo's Metro).

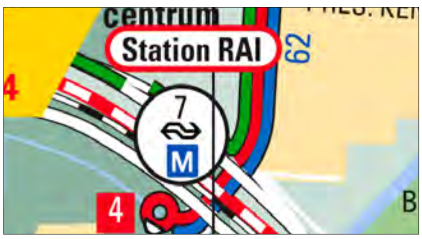
Sevilla, Red de Líneas. Spain.

• **Classic Style** *(mostly found in British, Italian and Portuguese towns)*
One line for all services of each transport mode; individual services indicated alongside the lines (i.e. Sevilla's Red de Línea).

• **Scandinavian Style** *(mostly found in large cities of Scandinavia and some cities of Germany, Austria and Spain)*
Similar to the classic style, but applied to sub-divisions of the network, such that only two or three lines appear on one street, each line in a different color

Scandinavian style: Oslo,Busslinjer

• **Dutch Style** *(mostly used in the Netherlands)*
Similar to the Classic style, but with a different symbol for each transport mode, i.e., a double line for trams, and a double line with alternating black and white filling for railways.



Dutch style: Amsterdam, Network

Other styles may still be identified or created in the broad scope of possible representations of transport routes (Avelar, 2008). Morrison acknowledges the French style and the Classic style as two extremes recognizing that both are likely to represent the map user with difficulties if used their purest form. Therefore the style adopted is likely to be a compromise between both. (i.e. the French style with bus services numbers printed along the lines, or the Classic style applied to lines of 2 or 3 different colors).

Indeed, there were major problems while applying Morrison classification to the survey, since many maps combine features from both styles (French & Classic). In despite of this, a tendency to represents transport systems with the French style is evident- especially in maps that solely represent Metro-Rail systems. Systems with combination of segregate and surface modes tend to use Classic style maps or combination of styles.

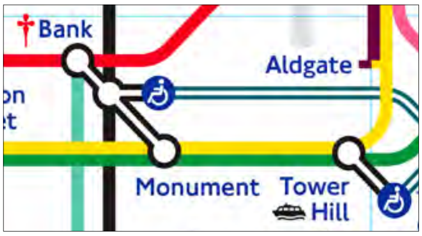
According to Morrison the choice of style depends on many factors but primarily in the number of modes and services to be depicted. He suggest thought, that when it is possible the French Style is preferable since it makes it easy for the traveler to follow a bus route on the map, and to see the name of its terminals. A trade off in French style map is the difficulty to pick out the numbers of the bus, which run along a specific link. In the other hand on a Classic style map it is easy to see which bus services follow a particular link, but difficult to follow the route of a particular bus service or to determine the name of its terminus.

Finally Morrison suggests a guideline to select a suitable "style" for a map. This is mainly base on the number of modes, the number of services and overlaps. These guides have been considered in Chapter 8.

Intermodality

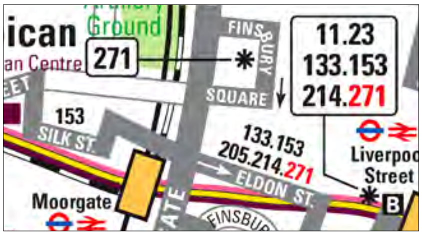
The future of transport can certainly expect an increment of travel speed, significant growth in the number of travelers and increased demand for precise and timely information by travelers (Ghosh and Lee. 2000).

From the ordinary traveler's point of view, the real advance and the direct benefit should occur in the seamless and natural integration of the modes of transportation. As a result of the integration, the traveler will need access to accurate status information of any transportation mode, anywhere in the world, from any point in the system [...]. Precision and timeliness of information are crucial to developing faith and trust in the system among travelers, which may be delivered, in general, by distributed systems (ibid).



London Underground Diagram. UK

According to Rodrigue (2006) there is a growing trend towards integrating the modes through intermodality and linking the modes ever more closely. However -instead of blurring the boundaries between modes- his view is that passengers and their journeys are becoming increasingly separated (segmented across most modes). (Rodrigue et Al., 2006)



Central London Day Bus Map. UK.

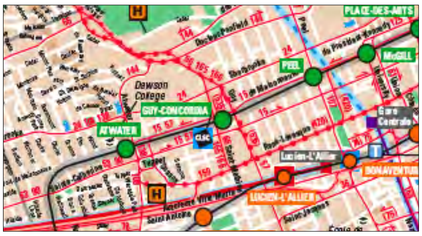
The separation of bus (surface modes) and underground in two different maps has been an extended practice for almost a century. The complexity of networks along a predisposition toward certain design inclination has probably perpetuated this graphic disassociation.

MTA Nnew York City Ssubway

Examples of this situation happen precisely in the cases of London and New York transport systems (See images on the right). The underground diagram and the subway map are partial representation of larger intermodal networks. In both cases information about bus services is deliver through different sets of maps sub-divided by zones. In the case of New York certain integration is achieve through the use of a common graphic language and the display of text boxes indicating connections with bus services. In the case of London the graphic disassociation of languages is evident. It is interesting though, to notice that in both cases bus map of each city include the underground/subway network and their stations.

MTA Manhattan Bus Map. NY. USA.

The division of maps according to transport modes not only seems to contradict the purposes of intermodality but also today travelers' needs. A recent research from the Transportation Research Laboratory (Balcombe, 2004) has concluded that passengers should have a comprehensive and integrated approach to the system. According to this study it is not enough to provide detailed information on each metro, bus or tram line to build an efficient passenger information system. Passengers should be able to plan and accomplish their journey from A to B in a seamless way. Therefore, passenger information systems should be multi-modal and area wide. They should offer door-to-door information integrating all transport modes available in the concerned area, via one single medium (Balcombe, 2004).



Montreal Network Map

Milan, Rete metropolitana e tratte ferroviarie urbane

Horne et al. (1996) argues that geographically based bus map are more likely to offer one medium for all information requirements, throughout any journey. Inclusion of railway information creates an all-purpose public transport map, important if passengers are to use a coordinated public transport system to best effect (i.e. Montreal and Milan system maps).

The problems arise in portraying all this information in a concise, compact layout, in a form the user will understand, in devising an appropriate range of maps if more than one is needed to do the job, and in making the map(s) widely available (ibid.).

For designer Mijksenaar (2008) the graphic representation of intermodality is an strategic issue for todays' public transport agencies and a big challenge for mapmakers. According to him designers attention should be put on the "hubs" (Intermodal Interchange Points) since is here where the network meet. He discuss that no matter the kind of map projection selected, the access to an intermodal transportation systems will certainly pass through these points. Mijksenaar suggest that electronic devices may provide interesting interactive solution for this issue (i.e. different layers of maps according to modes) but at the same time recognize the relevance of exploring graphic solution for printed maps.

4.2 USERS AND THEIR INFORMATION NEEDS

Public transport passengers are often seen as a mass of people, barely distinguishable from each other except that some may be commuters or others school children. Passengers are, of course, not homogeneous and their diversity has not always been recognised in the design of information systems. Individual passengers have a variety of characteristics, some of which may make it difficult for them to access and understand public transport information (Denmark 2000).

The use of system maps -and transit information in general- is usually affected by each potential user's knowledge of local geography, knowledge of the transit system, and ability to process different types of information. The case of Vignellis' map for the New York subway system clearly demostrate this issue.

For this reason System maps should be designed to aid in the travelers' formation of a cognitive map (survey knowledge), complementing any pre-existing knowledge that the traveler may have about the local area. It could include all major elements of the transit system, including routes, major transfer points, and enough topographical and landmark information for the traveler to orient themselves (Cain, 2007).

The diversity of travellers –especially in large multicultural cities- certainly tensions the work of designers in defining a proper graphic strategy. Several decisions such as the kind of symbols, the selection and size of the typeface and the choice of a language can determine the inclusion and segregation of different groups of users into the system. In order to understand users characteristics some aspects such as cultural background, information needs and visual preferences must be consider.

Cultural Differences

According to Montello (1995) cultural differences should not necessarily affect people special cognition since many important aspects of spatial cognitive structures and processes are universally shared by humans everywhere. In this context he refers to "culture" as a body of knowledge and beliefs that is more or less shared between individuals within a group and transmitted across generations. Essentially, specifies preferred or accepted patterns of ideation and behavior dealing with religious and value systems, social systems, and material/technological systems.

For Montello many of the differences that affect spatial perception and thinking are actually not due to culture but other factor that vary within cultures, such as professional training and expertise, social class, and so on. Another aspect pointed out by Montello is that most of the differences in spatial cognition occur primarily between traditional and technologically developed cultures, not between different technologically developed cultures.

For people in all cultures, facility at pictorial perception depends on training and/or practice. The ease with which this skill can be acquired is still unclear, as in the case of learning to interpret a cartographic "picture" such as a Public Transport Map (Blaut, 1991; Liben & Downs, 1989).

In this direction Mijksenaar (1999) argues that reading maps, just as reading directions and graphics, requires a certain level of knowledge and training. *The different ways of depicting information on maps belong to the set of map conventions, and most of them have to be learned.*

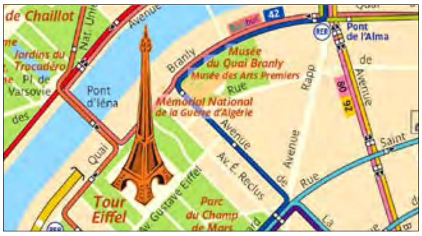
However as it will be discussed later in chapter 9 the familiarity and exposition to public transportation may affect the learning process.

Information Needs

Different studies base on public transportation users permit to identify several issues that affect user comprehension and interaction with information material. These studies have demonstrated that transit's users have a wide range of different information needs and preferences. Cain (2007) has typifies the different issues that affect these needs and preferences as follow:

- **Users Local Knowledge**

Local knowledge obviously reduces the amount of new information required to complete a trip-planning task. Research shows that many individuals form a "cognitive map" of their local area, onto which they can simply superimpose the route of the trip they wish to take, using familiar landmarks to chart their progress (Higgins & Koppa, 1999). Someone that is new to the area will not have



RATP Paris Bus| T. France

RomaCitta

the advantage of a "cognitive map" and will require much more information on local topography, landmarks and transportation infrastructure to plan their trip. This is reflected in some transport maps done for main tourist centers such as in Paris (RATP Paris Bus | T) or Rome (RomaCitta).

• User's Transit Experience

An individual that regularly uses transit will have different information needs from someone who has never used transit before or that has never used that particular system, even if they are both planning the same trip. Frequency of transit use also has an influence. A regular user will be much more familiar with service characteristics and information conventions that someone who occasionally or rarely uses transit.

Cain (2004) found that there was no difference in the trip planning ability of transit users and non-users. However, there was a statistically significant difference in the time taken to complete the trip planning task. Those that never used transit took the longest to complet the task, while those that used transit four or more times a week took the least amount of time.

• Trip Type

There are clear differences in the need of information and trip planning time required by frequent users (i.e. commuters) than those who access the system for the first time. In a british study about bus travelers Balcombe and Vance (1998) found that 83 percent of regular passengers declared that they required no information whatsoever before boarding a bus for a regular journey. However, for new trips, only seven percent stated they would not need any information before taking the trip. When testing trip planning ability, this study found that:*"Infrequent bus users performed proportionately rather well [...] while regular travelers seemed to have considerable problems [...]."* Balcombe & Vance (1998). Thus, being a regular transit user may actually reduce trip-planning ability, due to lack of need to practice the skill.

• Physical and Cognitive Impairments

Successful transit use requires a certain array of physical and mental abilities, as does the process of transit trip planning. Transit users each have a different set of physical and cognitive attributes that influence their ability to plan a transit trip. Cain (2007) identify three main categories of impairments that affect the access to travel information through printed material:

- Visual Impairment and Blindness: Severity can vary from poor eyesight, tunnel vision and color blindness up to full blindness. May have great difficultly, or be completely unable to read any kind of printed information material such as a map

- Dexterity impairment: refers to reduced function in arms and hands that makes moving, turning or pressing objects difficult or impossible. May make it difficult to hold and even unfold a map.

- Cognitive Impairment: There are many different types of cognitive impairment, including dyslexia, dementia, Alzheimer's Disease and other age related cognitive limitations. Cognitive impairments can affect attention, reasoning, memory, coordination, reading communicating, social competence and emotional maturity. Transit trip planning requires several different cognitive abilities.

Cognitively impaired passengers can have dificulties with the comprehension of information and the planning process. May need personal assistance in trip planning and trip execution. Older people tend to take longer to learn new skills and can have difficulties with short-term memory.

- **Demographic Factors**

- Gender

Wayfinding research from the field of psychology shows that there are fundamental differences in the ways in which males and females navigate (Lawton & Kallai, 2002).

These studies suggest that men are more likely to use global reference points, such as cardinal directions, while women are more likely to rely on landmark-based route information. A similar observation was made by Cain (2004), who found that females had much more difficulty with travel directions provided in cardinal direction format.

In the same report, Cain (2004) also found that, on average, females scored lower than males on trip planning assignments and took longer to complete the exercises, and that these differences were statistically significant. However, a British study (Balcombe and Vance,1998) found that it was "not possible to distinguish consistently between the ability of men and women." The landmark-based approach to wayfinding favored by women is consistent with the first stage in the development of spatial knowledge. This suggests that males are more likely to progress to the more advanced stages of spatial knowledge development that involve the formation of "cognitive maps" (Higgins et al., 1999).

- Age

The aging process can have physical impacts such as diminished eyesight and mobility as well as some cognitive impairment and diminished ability to learn new skills. Age can also play a part in determining an individual's attitude towards new trip planning tools. Many older people prefer human assistance to using selfservice terminals (Gill, 1997). One study found that younger persons were more comfortable with high-technology devices, and were therefore more likely to use them when planning and executing their transit trips (Cluett, et al, 2003). Cain (2004) found there was no difference in the trip planning performance across different age groups, but there was a statistically significant difference in the time taken to plan a transit trip, with over 50s taking longer than under 50s. The 18-34 age group completed the trip planning task in the shortest average time. Balcombe and Vance (1998) found that the success rate for transit trip planning declined with increasing age.

- Education Level

Few studies have looked at the influence of education level on transit trip planning ability using printed information materials. Cain (2004) found there was no statistically significant difference in ability, but a statistically significant difference was found in the time taken to complete the exercise. Those with no high school diploma took the longest, on average, to complete the exercises while those with a post-graduate degree took the shortest time. The same trend was also observed in the New Jersey Institute of Technology Study (Fallat et al., 2004), which found that the average time taken to complete transit planning exercises using printed materials decreased as education level increased as did the average number of errors.

Another study compared the preferences for information media of people with different education levels (Cluett et al., 2003). This study found that those who only completed high school indicated a greater preference for trip planning services, alternate routes and stop locations, and also expressed a greater preference for obtaining information from a member of transit staff. Those with a higher level of education expressed a greater preference for using the Internet, video or kiosks to access information.

Overall, this suggests that people with higher levels of education are better equipped with the cognitive processes required in transit trip planning using printed information materials and thus are more willing to take responsibility for planning their own transit trips. This may explain the preference for trip planning services among people with lower levels of education where responsibility for the trip planning task is essentially deferred to another person or interactive information source.

• Language

Tokio Metro Network. 2007

Tokio Subway Route Map (English). 2007

The ability to perform the planning task obviously requires some level of proficiency in the language in which the Map is presented.

Most of the time transit agencies normally provide materials in the main languages spoken in the local area. However some cities with high average of immigrants and tourists have considered the implementation of maps in different languages (i.e. The London underground diagrams). Version of maps in alternative languages can become critical for users not familiar with a different writing system (i.e. Cirilic, Roman, Arab or ideographic). A good solution in theses cases is to use numbers or psctogram complementing station names such as in Tokyo's metro map (Pictures on the left).

According to Cain variation in the transit user population affects both the ability of individuals to carry out the trip planning task and information aid preferences. His study notice that groups that tend to have greater difficulty with trip planning using printed information materials (females, older people, and those with lower education levels) are also the ones that tend to be highly represented in transit ridership. Thus, there may be an ironic situation where the people most likely to be transit users are also the least equipped to plan their own trips. This paradoxical issue has also been notice by other authors and can be summarized in the following quote:

"In general, the people who performed worst in the comprehension exercises were the very ones who comprise the core of the bus-using population, who are the most dependent on buses and have the greatest practical experience of using them. This implies that such people use the buses, not with the aid of timetables, but in ignorance of them, relying instead upon custom, experience, observation, and word of mouth." Balcombe et al. 1998.

• User's Preference

According to Avelar (2008) Transport users may have certain preferences that may determine the design elements and also style of the map. A poor design can confuse or frustrate map users. Therefore the mapmaker's function is not to supply a quick fix, but to be prepared to modify what might appear at first to be a nice, stylish cartographic design in the opinion of the mapmaker so as to be comprehensible enough for a large number of transport users in the context considered. Ideally, the resulting map can even become a source of pride for the transport company and residents of the city. (Avelar, 2008)

The case of Madrid new metro maps appears here as an interesting example that illustrate the importance of users' preferences. Like many metro maps around the world, Madrid's has been based on Harry Beck's revolutionary 1933 map of the London Underground, which eschewed geographical realism for simplicity of use.

As the city's transport network has expanded in all directions the map has turned into an awkward, multicolored tangle of lines and symbols that has tourists scratching their heads in confusion (Catán, 2007).

In 2007 matters got significantly worse. The Madrid regional government is to open no fewer than 80 new stations (before local elections on May 2007). Authorities realized the impossibility to accommodate all the new lines and station within the existing map, deciding to commission a complete redesign, the first since the 1980s.

The new maps, designed by Rafa Sañudo from design studio "RaRo", stressed even more the distortions generated by Beck's model doing away with all diagonal lines. With the new (0º and 90º) structure, stations that were on a straight line now appear divided by 90-degree turns and many geographical relationships between well-known landmarks appears to have been reversed.

Although in the new map labels appear easier to read, according to the local Newspaper El País many Madrileños are still outraged that their city has apparently been redrawn without their consent. Among the comments registered in this influencial newspaper website were: "It's a monstrosity," one said. "Idiotic and unnecessary. The old one was more realistic" (Catán, 2007)

Plano Metro, Madrid, Spain. 2006

Plano Metro, Madrid, Spain. Diseño RaRo. 2007

• Maps users main task and problems

Along the acknowledgment of users' characteristic, the study of the main graphic problems presented by Public Transport Maps is necessary to evaluate and improvement any further design decision.

A major investigation on maps user task was also conducted by the American NCTR in 2004. This study, entitle Design Elements of Transit Information Material investigated in detail how the general public perform in the planning of a transit trip using printed transit information materials. According to the study the main problems encountered at the system map stage of the trip planning process were in locating the origin and destination on the system map, and in coping with the small font sizes on the map. Although less frequently mentioned by participants, there were some problems with selecting the routes, such as locating the transfer point and using the color scheme (Cain, 2004).

The study about map comprehension was divided in two stages according to major tasks: identifying trip of origin and destination and selecting bus routes and Transfer Point

• Identifying Trip Origin and Destination

According to the study the first stage in the planning of any trip is determining the trip's origin and destination. For the study, this meant locating the specified trip origin and destination on a system map. For most participants, this was a straightforward task, and the two points were located either by using the street addresses provided, or simply scanning the map at random until the points were found. Despite this high level of success, some participants did have difficulty locating the points, taking a considerable amount of time. Sources of difficulties included the fact that the font sizes used to identify the points of interest were relatively small, the fact that all the points of interest were shown in the same color, and the fact that some street intersections used to identify the points were not shown on the system map.

• Selecting Bus Routes and Transfer Point

Having correctly identified their origin and destination on the system map, participants then had to determine which bus routes to use for their trip. This involved locating different color coded routes adjacent to origin and destination, following the routes through the town and decided where to transfer. It was found that both routes were correctly identified by most participants, showing that there was a high level of success at this stage. However, some problems were identified at this stage such as:font size too small on routes number, poor color contrasting on adjacent routes, identifying locations where transfers can be made between routes, following routes through "congested" areas such as transfer centers

This study provide valuable information regarding the most difficult tasks described by maps users. Among them:

- locating origin / destination
- identifying routes
- font too small
- identifying transfer point
- poor color contrasting
- following routes through congested areas
- locating streets
- poor labelling / lack of comprehensive legend on system map

4.3 CONTEXT

Important elements of the local and regional contextual framework, such as reference places and landmarks that people are familiar within the area, could be provided to call attention of the audience (HGSD, 2005). The local interests of authorities, transport operators and other stakeholders can also have implications for map design. Political, social, historical and cultural values that can affect the visualization should be also taken into account.(Avelar, 2008)

The amount of context information included in the map can greatly affect its utility. According Agrawala (2000) context information can directly supports navigation and help users locate the route in relation to the rest of the environment (Agrawala and Stolte 2000). The importance of context information in Public transport maps has been illustrated in the case of the New York subway map: the representation of the urban pattern (i.e main streets and avenues) and the depiction of spatial features (i.e. landmarks, the Central Park, the Hudson river) demonstrate how context information not only support orientation but also enhance users' appropriation and identification with the map.

Transports maps and the images of cities seems to be strongly couple in users' minds. From here the importance of designers to recognize the elements that better provide context information. Lynch (1960) identifies five elements that people use to form mental representations of cities: paths, landmarks, districts, nodes and edges. For him a legible city would be one whose districts or landmarks or pathways are easily identifiable and are easily grouped into an over-all pattern. Grabler et alt. (2008) affirm that these elements have a number of properties that make them essential in navigational tasks and in the general understanding of a new environment. A review of these elements might give mapmakers a structure on which to select suitable contextual features and design more memorable and imaginable transport maps.

System Map. Washington D.C. 2008.

The images on the side show how a transport map -such as the Metro System Map of Washington D.C.- can be break down into these five elements. Even its schematic approach this map represents some essential characteristics of the city and its surroundings that are key spatial references for local Washingtonians (i.e. The Belt Way 405, and the County limits, Parks, the Potomac River, the "Mall," and Monuments).

- Paths

Paths are channels along which the observer customarily, occasionally, or potentially moves. They may be streets, walkways, transit lines, canals, railroads, etc. For many people, these are the predominant elements in their image. People observe the city while moving through it, and along these paths the other environmental elements are arranged and related. (Lynch, 1960)


Paths elements in Washington D.C. System Map.

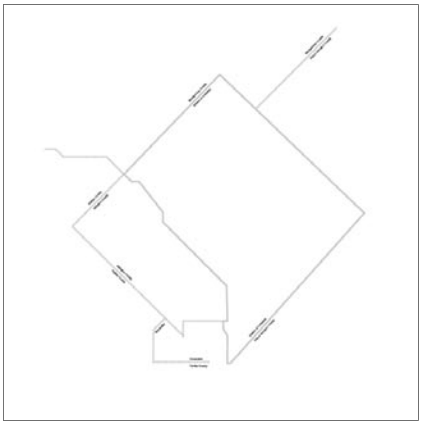
In public transport maps paths are refer mainly to transport track and roads since they are the predominant trail for urban navigation. They are usually represented through lines.

- Edges

Edges are the linear elements not used or considered as paths by the observer. They are the boundaries between two phases. Linear breaks in continuity: shores, railroad cuts, edges of development, walls. They are lateral references rather than coordinate axes. Such edges may be barriers, more or less penetrable, which close one region off from another; or they may be seams, lines along which two regions are related and joined together. These edge elements, although probably not as dominant as paths, are for many people important organizing features, particularly in the role of holding together generalized areas, as in the outline of a city by water or wall (Lynch, 1960).


Edges elements in Washington D.C. System Map.

Many cities contain elements such as rivers, city walls, and roads that serve as linear breaks in continuity between regions. Such edges can be barriers which close one region off from another, or seams along which two regions are related and joined together. Edges are often defined by the boundaries of the other four city elements. For example a highway serves as a barrier but also as an important path (Gabler, 2007).



District elements in Washington D.C. System Map.

- District

District are the medium-to-large sections of the city, conceived of as having two-dimensional extent, which the observer mentally enters “inside of”, and which are recognizable as having some common, identifying character. Always identifiable from the inside, they are also used for exterior references if visible from the outside. Most people structure their city to some extent in this way, with individual differences as to whether paths or districts are the dominant elements. It seems to depend not only upon the individual but also upon the given city (Lynch, 1960).

Some areas of a city may have common identifying characteristics along a variety of dimensions including building type, building use, types of inhabitants etc. Neighborhoods such as Chinatown, Little Italy and the Mission are examples of such districts.

Nodes elements in Washington D.C. System Map.

- Nodes

Nodes are points, the strategic spots in a city into which observer can enter, and which are the intensive foci to and from which he is traveling. They may be primarily junctions, places of a break in transportation, a crossing or convergence of paths, moments of shift from one structure to another. Or the nodes may be simply concentrations, which gain their importance from being the condensation of some use or physical character, as a street-corner hangout or an enclosed square. Some of these cncentration nodes are the focus and epitome of a district, over which their influence radiates and of which they stand as symbol. They may be called cores. Many nodes, of course, partake of the nature of both junctions and concentrations. The concept of node is related to the concept of district, since cores are typically the intensive foci of districts, their polarizing center. In any event, some nodal points are to be found in almost every image and in certain cases they may be the dominant feature. (Lynch, 1960)

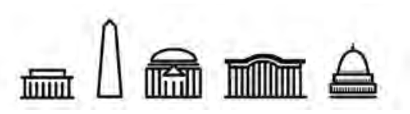
In transport Maps nodes are usually represented in Stations, but many cities also consider, parks, town squares, beaches and busy intersections as points where people tend to congregate. Such nodes are particularly relevant for tourists because they are good places to mingle with the local population.

Landmarks elements in Washington D.C. System Map

- Landmarks

Landmarks are another type of point-reference, but in this case the observer does not enter within them, they are external. They are usually a rather simply defined physical object: building, sign, store, or mountain. Their use involves the singling out of one element from a host of possibilities. Some landmarks are distant ones, typically seen from many angles and distances, over the tops of smaller elements, and used as radial references. They may be within the city or at such a distance that for all practical purposes they symbolize a constant direction. Such are isolated towers, golden domes, great hills. Even a mobile point like the sun, whose motion is sufficiently slow and regular, may be employed. Other landmarks are primarily local, being visible only in restricted localities and from certain approaches. These are the innumerable signs, storefronts, trees, doorknobs, and the other urban detail, which fill in the image of most observers. They are frequently used clues of identity and even of structure, and seem to be increasinglgly relied upon as a journey becomes more and more familiar. (Lynch, 1960)

The principal characteristic of landmarks is that they are uniquely memorable in the context of the surrounding environment. An important number of Public Transport Maps examine in the survey (61%) display large physical areas acting as geographic landmarks in the environment (i.e. parks, river, mountains, lakes,). Smaller but relevant features such as buildings, monuments, bridges and tourist attraction also serve as referential marks. Almost half of the samplers reviewed present this kind of landmarks that can be depicted with diverse rendering solutions such as points, pictograms, 3D graphics and realistic illustrations.



Monuments Pictograms in Washington D.C. System Map. Design Lance Wyman.

Paths and nodes are the most preponderant graphic elements represented in Public Transport maps, however it should also be notice that none of the element define by Lynch above exist in isolation in real case. Districts are structured with nodes, defined by edges, penetrated by paths, and sprinkled with landmarks. Elements regularly overlap and pierce one another. (Lynch 1960)

Context Matter

Maps are powerful instruments that influence our interpretation of the space around us and the phenomena that occur within it. (Richards, N. 1999)

Public transport maps -like all maps- can also work as "an excellent mirror on culture and civilisation" (Thrower, 1972). Although less documented there are several cases compiled during this research that suggest how these maps 'mirror" cultural, political and social aspect of their users and authors. Following some examples:

• Berlin Reunification Map

The Berlin Wall divided the city into two halves, severed traffic links, separating the transportation system and Berliners. After the fall of the Berlin Wall in 1989, German authorities launched several plans to rapidly reintegrate the city. Among these strategies was the integration of the fragmented transport system. BVG (Berlin Transit Corporation) commissioned the information plan to local designer/typographer Erik Spiekermann (Meta Design). The design of the Metro-Rail map was consider a very complex task since it not only displayed a transport network, but also symbolically synthesized the effective reunification of the city. (Wurman. 1996).

Berlin Map. 1993

• Mexico City Map's Pictograms

The use of pictograms has a preponderant role in identifying Mexico City Metro stations. The purpose of the pictograms -designed byAmerican designer Lance Wyman in 1968- is still controversial. Although there are not evidences, it has been suggested that their application in maps and signage was aim to aid potential illiterate users. Another arguments is that pictograms were part of a large information strategy planed to facilitate the navigation of multilingual users during 1968 Olympic Games hold in same city.

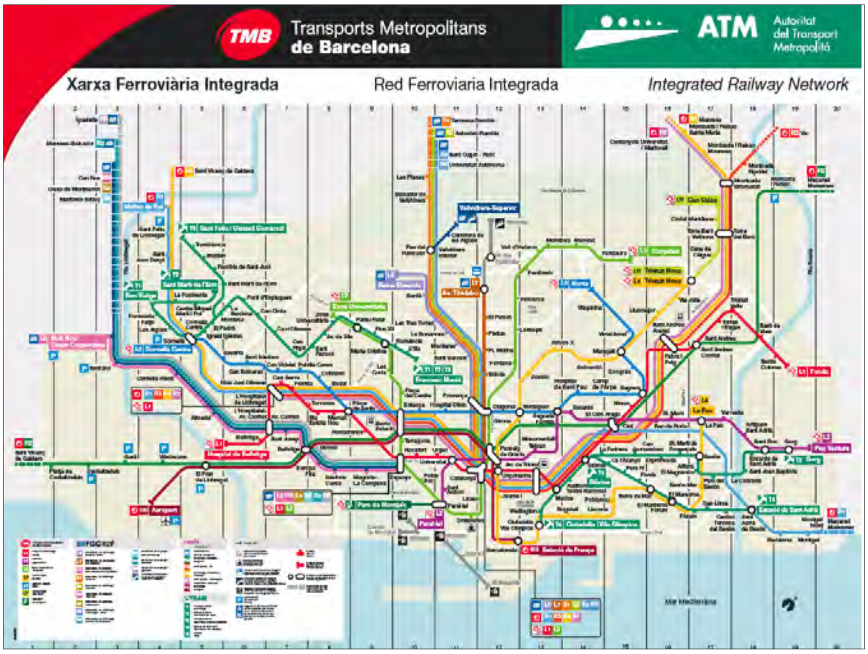
Mexico City Meetro Station'd Pictograms. Design Lance Wyman.

• Barcelona's Map Orientation

Cartographic orientation refers to the indication of direction on a map and it is usually indicated with a north arrow (Slocum et al. 2004). An interesting exception regards most maps designed for Barcelona's transport systems, which are not oriented with geographic or "true" north at the top. Although this operation occurs in many cases when the shape of the mapped area, does not fit with a regular page format, in this case the layout seems to privilege Barcelonans' topographic notions of their urban space. While the mountains are at the top, the Mediterranean see is on the bottom. Similar spatial attachment appears to happen in other cities like The Hague. (Mijksenaar, 2008. Interviewed by the author).

Cases such as the one mentioned above show how the creation of some Public Transport Maps are also tightly related with local circumstances and can be charged with political, historical and cultural connotations. This condition put in evidence the need of tailored solutions and the significance of map uniqueness. It also increases the complexity behind its design and the responsibility of mapmakers in interpreting and constructing local identity.

Satelite image of Barcelona. Google Map, December 2008.



Barcelona's metro map oriented with the East at the top.

Chapter 5
Maps' Design Elements

The following chapter introduces essential notions of map design, mainly based on thematic cartography literature (Dent, 1993 ;Slocum et al. 2004). It pretends to organize the analysis of Public Transport Maps, defining graphic attributes through a sequential process that could eventually support the design of this maps.

5.1 THE DESIGN OF PUBLIC TRANSPORT MAPS

Creating a map for transportation may seem to be a straightforward task, but – as it has been discussed previously- the underlying design of most maps is quite complex (Agrawala and Stolte, 2001). Mapmakers employ either consciously or subconsciously a variety of cartographic techniques, including simplification, abstraction and symbolization, to improve the clarity of the map and to emphasize the most important information (Wood and Keller, 1996).

The choice of a design for a Public Transport Map is subject to more criteria than those needed in conventional map settings for reasons such as: the length of lines does not have necessarily correspondence to the actual length of a trajectory, often direction and distances are only roughly preserved and the scale factor is not constant for the entire map.

Yet mapmakers have to consider result quality, resource consumption and users' comprehension of the represented transport system. Some times, it is desirable to distort elements beyond the traditional distortions required for cartographic reasons, in order to omit unnecessary details for transport users and make the maps more readable for quick wayfinding tasks.

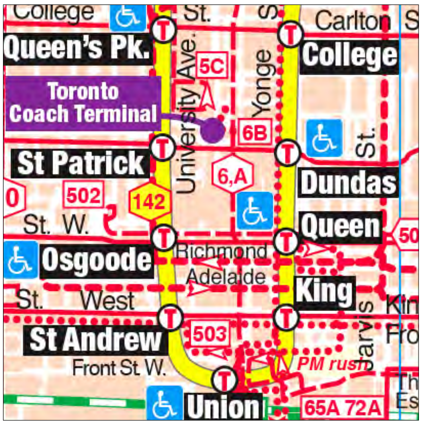
However, in general, mapmakers, when producing a schematic map for transportation, take their main design decisions based on their experience either with accurate maps or with graphic design in general without knowledge of cartographic rules. (Avelar.2008)

The control over some cartographic concepts might support public transport mapmakers in taking more conscious design decision while approaching the creation of public transport maps.

5.2 MAP'S DESIGN ELEMENTS

Planning is the key to developing an effective system map, which is basic to any public transportation user's information program.

Maps are instruments of visual communication (Dent, 1993). The marks that make up a map are visual elements, and transfer of information takes place through them. The map designer arranges the visual elements into a functional composition to facilitate communication. This functional approach to design was first expressed by Arthur Robinson (1952); "Function provides the basis for design." That something is functional means that it has been "designed or developed chiefly from the point of view of use." Therefore, design decisions regarding the map's elements should be made on the basis of how each element is to function in the communication. The challenge then, is to make the map aesthetically pleasing as well as functional (Dent, 1993).



Detail Downtown Area, TTC Map, Toronto

Most maps contain elements such as titles, legends, scales, credits, mapped areas, graticules, borders, symbols, and names (texts). The task of the designer is to arrange these into a meaningful, and attractive design. (Dent, Mijksenaar)

One of the first essentials in creating a system map is to determine the type of data that should be included. This is followed by data gathering and then by the organization and presentation of the data. Each data group should be weighted according to its importance to the map-reader. A choice of symbols for each feature must be made and the map assembled.

The interaction and concentration of these elements in a limited area can create multiple representational problems such as the concentration of information in some areas (i.e. Toronto's TTC Map's downtown area), the superposition of routes, the convergence of lines towards main stations and several labeling problems. From here, the need to finds the correct balance in the amount of information that is included in such a map. According to Cain (2007) information deemed essential to the planning of the trip needs to be included. Information not deemed to be essential should be minimized; while information not necessary for trip planning should not be included. However to determine which information is or not essential is considered in most cases a design decision.

In order to tackle these conflicts mapmakers not only select the features but codified them, define a suitable size and layout for the map; apply selective distortions in overcrowded areas, decide the degree of schematization and a suitable style, the right treatment of lines, routes intersection and routes directions; the shape of stations; the display and labeling of station names, services numbers and other relevant textual information; the selection and rendering of geographical references and landmarks; among many other representational issues.

Attempting to solve these requirements designers apply –consciously or subconsciously– various cartographic concepts and techniques to emphasize important information and improve the clarity of map content (Avelar et alt. 2006). The proper understanding and application of these operations varies according to the expertise of the mapmaker and certainly can determine the map final output and its users interpretation.

Since Public Transport Map is in part a representation of reality and partly a product of its maker, the design characteristics can also vary widely. Mapmakers can still use their ability to innovate, applying the same set of design elements differently or adding other cartographic features to the schematic network, according to users' priorities and context requirements. Spatial conflicts between lines and symbols have to be solved, in order to preserve the topology of the transport network and to maintain good graphic association for the map user. It is the legibility of the map that is important. (Avelar, 2008)

5.3 MAPS ATTRIBUTES

As a graphic interface between reality and mind, the map presents a selective view of reality— selective in the space it portrays, the viewpoint it offers, the objects its includes, and the symbols it uses to represent these objects (Slocum et al. 2004).

Most cartographic literature agree that maps have three basic attributes: *Scale*, *Projection* and *Symbolization*. According to Monmonier (1996) each of these elements is a source of distortion. As a group, they describe the essence of the map's possibilities and limitations. No one can use or make map safely and effectively without understanding map scales, map projections, and map symbols (Monmonier 1996). Many authors agree though, in considering *Lettering* (typography) as a graphic (cartographic) symbol since it is an integral part of maps (Robinson, 1952; Dent, 1993). Slocum et al. (2004) even considers typography as a map element in its own right.

- **Scale**

Maps are scale models of reality. Most maps are smaller than the reality they represent, and map scales tell how much smaller (Monmonier, 1993). Scale refers to the degree of reduction and is commonly stated as ratio of distance on the map to distance on the ground (i.e. a ratio of 1:50.000 that means that 1 centimeter-line on the map represents 50.000 centimeters stretch of road). Maps can also state their scale as a short sentence (i.e. One centimeter represents 500 meters) and as a simple graph (probably the most helpful and safest since simple bar scale portrays a series of conveniently rounded distances appropriate to the map's function and the area covered. A simple graph is also safer because it still work independent the reduction and enlargement of the map format (Monmonier, 1993).

- **Projection**

Cartographic projection refers to the mathematical transformation that assigns objects on curved, three-dimensional surface to locations on a flat, two-dimensional plane. Map projection tends to distort scale, distance, and area, and the projection chosen can either serve or thwart the mapmaker's goals (ibid).

- **Symbolization**

Symbols complement map scale and projection by making visible features, places, and other locational information represented on the map. By describing and differentiating features and places, map symbols serve as a graphic code for storing and retrieving data in a two-dimensional geographic framework (ibid).

Mass-produced maps –such as Public Transport Maps– must address a wide variety of questions, and the map's symbols must tell the user what's relevant and what isn't. These maps need a symbolic code based on an understanding of graphic logic and the limitations of visual perception (ibid).

- **Lettering**

Map lettering is an integral part of the total design process. Lettering on the map make possible the communication between mapmaker and map readers since - in most cases - written language can not be ignored (Dent, 1993).

Lettering has always been a challenge in mapmaking -particularly in special purpose maps -such as Public Transport Maps - where the identification and placement of multiple paths and nodes in a condensed area usually demands a clear, consistent, presentation of text.

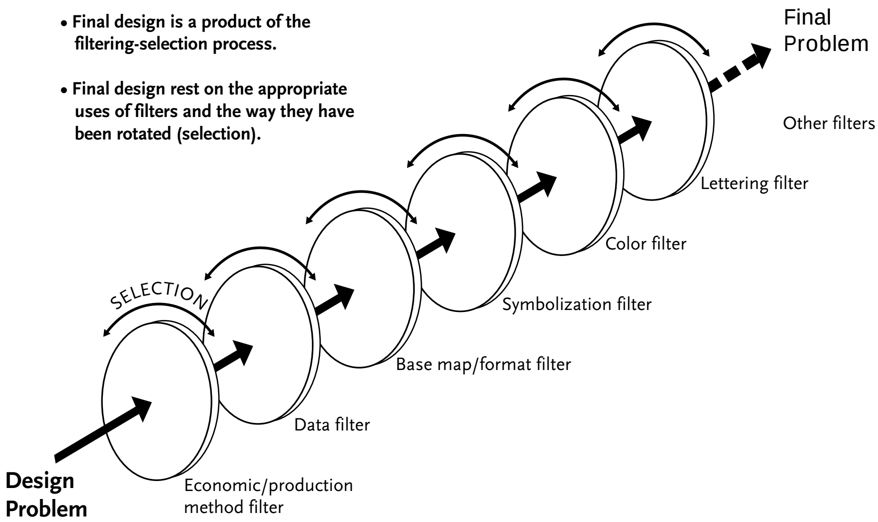
5.4 MAP LEVELS

Usually maps can be considered to have two or more planes or levels. Map design deals with the arrangement of the map's elements at each or between levels. Map's design elements become marks on the map that must be arranged into graphic composition suitable to the maps' communication purpose. The elements include all basic attributes of maps (scale, projection, symbols and lettering). By using design techniques such as generalization, the composition elements are arranged to satisfy the design goals. These processes require a planar distribution of elements and its organization in the map.

Most designers would agree that all design takes place in sequential steps, ordered in a way that eventually yields the planned result. Identifying these steps or stages in design is helpful in learning how design takes place (Dent, 1993).

Different planes or levels compose maps. Dent illustrate this in the following figure where a series of filters in which selections are made at each stage, allowing design activity to continue until an appropriate final solution is researched. This analogy directs attention to the fact that map design is a complex issue involving many decisions, each of which affects all the others.

Dent model of Map Design as a filtering-selection process. In this view of design, a series of filters must be rotated (selection), allowing design activity to continue until an appropriate final solution is reached (Dent, 1993).



Most of the time the levels are differentiated by visual importance. Each component of the map belongs to a specific level. More than one map element can be placed on a particular level, but a single element should never be assigned to more than one level.

Map composition can be defined as the arrangement of the map's elements that takes place at each level and between levels. The arrangement at a given level may be called planar organization, and that between levels hierarchical organization. Hierarchical organization is also referred to as the visual hierarchy. The map author ordinarily approaches design solutions by simultaneously manipulating all elements at and between all levels. Therefore map composition has an intellectual and a visual dimension. Dent (1993) recognize the following purposes to map composition:

• Forces the designer to organize the visual material into a coherent whole to facilitate communication, to develop an intellectual and a visual structure

• Stresses the purpose of the map

• Directs the map reader's attention

• Develops an aesthetic approach for the map

• Coordinates the base and thematic elements of the map-a critical factor in establishing communication

• Maintains cartographic conventions consistent with good standards

• Provides a necessary challenge for the designer in seeking creative design solutions

5.5 A GRAPHIC FRAMEWORK FOR PUBLIC TRANSPORT MAPS

As most maps, Public Transport Maps are usually made of several distinct levels. In planning a map, the designer assigns the various map elements to these levels. This causes the designer to think of each element in its proper role, thus leading to a more organized design. Thinking in this way can facilitate the whole process of analyzing and designing maps.

For the purpose of this study, the design elements of Public Transport Maps have been organized and examined through basic cartographic attributes (Scale, Projection, Symbolization and Lettering). To simplified its comprehension -specially for those mapmakers not familiar with cartographic notions- each cartographic attribute has been consider as a planar level, similar to the sequential layers generally utilized by designers while constructing maps. The levels have been name and organized as follow:

• **Structural Level (scale & projection)**

• **Graphic Level (symbolization)**

• **Typographic Level.**

This organization –partially builded on Robison notions of map's structure and lettering- also acknowledges the difficulties in identifying and distinguish variables such as *Scale* and *Projection* in Public Transport Maps (especially in highly schematized diagrams).

It also split *Symbolization* and *Lettering* in two different levels: *Graphic* and *Typographic*. The choice of the term *"Graphic"* instead of *"Symbolic"* has been done in order to avoid misinterpretations with *"Semiotics"*. The term *Lettering* -usually connoted with hand draw- has been replace with *Typography* which better reflect the selection and arrangement of text in today's maps design.

Finally, it can be argue that this structure emulates in some way the sequential steps usually engage by designers while approaching the design of a map.

Chapte 6
Atributes And Visual Variables In Public Transport Maps

Presentational problems are generally inversely proportional to the scale of mapping. Issues include the size of the area and road density which are reflected in bus route density and complexity; variations in services at evenings and weekends, and how much supplementary information is considered necessary to be portrayed on the basic map. Cartographical styles vary, too. Whether to show road names and/or bus route numbers alongside or inside roads, or to group bus route numbers at bus 'interchanges', which specific methods to adopt for presenting background detail, how and whether to identify service variations, and so on, create major debate when cartographers with different attitudes meet to discuss these topics. (Horne, 1986)

In elaborating adequate symbology to represent route data, both precise data representation and visual clarity are top priorities. The representation of route-based data requires three central characteristics of the mapping problem to be considered: the special constraints of the lines (i.e. events occurring on routes should be constrained to preserve topological relation and maintain good graphic association for the map reader), the properties of events (e.g. the event data have characteristics inherent to the route, such as directionality, sidedness, punctual or linear representation, and chronology), and the properties of the thematic data for the cartographic treatment of lines (Bertin 1983 and Kennedy 1999 quoted in Avelar et alt. 2006).

The following chapter describes how cartographic attributes - *Scale, Projection, Symbolization and Lettering* - are applied in the creation of Public Transport Maps. It is organized in three parts: *Structural, Graphic* and *Typographic* according to the design levels previously introduced in previous chapter.

6.1 STRUCTURAL LEVEL *(Scale & Projection)*

Each representation is a simplification, a schema, a reduction. To represent is first of all reduce and then immediately schematized, in other words, decide what to lose and what form or level of reduction accept (Anceschi, 1992).

The review of two paradigmatic cases such as the London Underground Diagram and the New York subway Map has serve to illustrate how a diagrammatic approach – the most dominant form of representing inter-urban transport networks (MacEachen et Alt. 1987)- is not necessarily the only suitable way of representing Public Transportation to general users. The urban structure of the city seems to be a relevant factor in defining the "projection" (layout) of the map. After all not all transport maps are diagrammatic, and neither the diagrammatic ones are equal.

The arrangement of design elements in the plan, normally follow a set of "invisible" rules –an organization- that define the map purpose and its graphic configuration. A main difficulty in analyzing the structure of many Public Transport Maps is that in most cases the selection of a suitable scale and projection does not necessarily follow cartographic conventions. In many cases the recognition of a particular projection techniques and the application of different kinds of distortions by mapmakers seems to be based more on visual or intellectual aspects (designers graphic skill and their familiarity with cultural and geographic context) rather than mathematical or geographical correctness (Robinson, 1952).

Scale and Projection in Public Transportattion Maps

A conventional approach to cartographic design usually maintains a constant scale factor for the entire map. However, public transport maps frequently make scale distinctions and exaggerate the lengths of shorter roads to ensure that they are visible (Avelar, 2002).

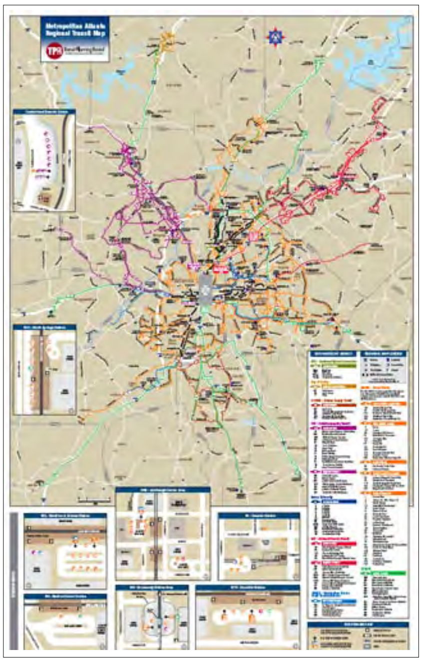
Scale Maps

The survey done for this thesis shows that only a 30% of the transport maps analyzed observe conventional cartographic scale. All these cases stand on large-scale (i.e. 1:50.000), otherwise it would be difficult to represent and identify details such as routes and stations in small geographic areas.

A main limitation in selecting large-scale maps for representing transport systems has to do with its final size and format (paper dimension). The lager the scale, the smaller the area displayed in a given size. This is particularly critical when representing large urban networks. For instance, the London Bus network has to provides a set of maps divided in subsections according to different geographic areas in order to show the whole system.

According to Denmark (2000) public transport maps should be able to shows the entire system simultaneously in a easy to handle format. Since the selection of a scale depends on the size of the area being mapped (Cain, 2007), public transport mapmakers are usually constrained to conciliate different maps scales according to the proper amount of information that must be communicated.

Metropolitan Atlanta Regional Transit Map
Bottom, map interior.Bottom right, exterior



Different Scale Maps

The distribution of transport services in most cities is uneven. While in the periphery services tend to be dispersed, in the centers or sub centers (i.e. Downtown or Main Stations), they tend to converge and overlap transforming these crowded areas in a difficult representational task. For this reason these areas tend to be enlarged.

A solution commonly applies in Public Transport maps consist in combining two or more different scales in the same map (i.e. Metropolitan Atlanta Regional Transit Map). According to Harrie (2002) travelers often need both, a detailed map as well as an overview map to navigate appropriately. This means that public transport user requires both large-scale and small-scale maps.

There are, principally, three different approaches to provide users with both large-scale and small-scale on a single map:

• **Separate maps**

The user switches between a small-scale map and a large-scale map (usually printed on opposite sides of the sheet). The user gets full view of both the small-scale and the large-scale map, but does not see the two maps simultaneously. Therefore, the user might have difficulties in connecting the information of the two maps. For example one problem detected in Vignelli's New York Subway map (1972) was that users were not able to relate the general network with the enlarged area printed in the other face of the booklet (Brozaft, 1976).

• **Parallel Maps *(Insets)***

One map is shown in the main map area (i.e. a network map) and a second map in a key-map or inset (i.e. a larger scale map). An inset is a smaller map included within the context of a larger map.

According to Slocum et al. (2004) insets can serve several purposes:

-To show the primary mapped area in relation to a larger, more recognizable area (a locator inset).

-To enlarge important or congested areas

-To show topics that are related to the map's theme, or different dates of a common theme, represented by smaller versions of the primary mapped area.

-To show areas that are related to the primary mapped area that are in a different location, or cannot be represented at the scale of the primary mapped area.

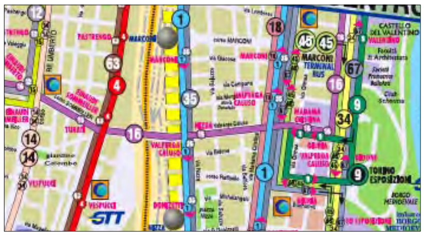
The size and position of an inset can vary depending on the purpose of the inset, the size of the map, and the other map elements. The styles of the inset are equally variable. In some cases the inset can be relatively subtle and in others the insets take on a central focus of the map. This might affect the attention and the relation with the primary mapped area. This is the case of today's transport map of Turin, which drastically change the style of the inset, making harder the connection between both, the main and the enlarged map.

A main advantage of insets is that users see the two maps simultaneously. However that the user sees the two maps at the same time it is often problematic to identify common objects in both maps. According to Morrison (1996), the simultaneous representation of maps presents relevant tracking problems for users that made them unsuitable for transport maps.

• **Variable Scale Maps**

Large-scale and small-scale cartographic data are presented in the same map. Most crowded areas of the city -often in downtown areas- are usually shown in large-scale (more details) and those areas with less concentration of data -usually peripheries- are shown in small-scale.

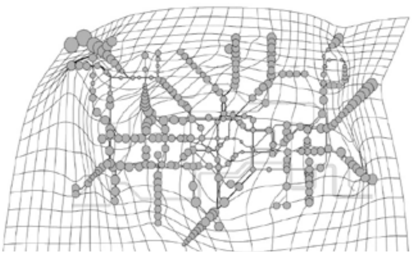
Fraction of the GTT Map, Turin, Italy. 2008



Detail downtown area, GTT Map, Turin, Italy. 2008

Inset downtown area, GTT Map, Turin, Italy. 2008

In 1994 Fairbairn and Taylor proposed this kind of variable-scale maps for urban areas. They argued that the density of objects is larger in the city centre and therefore the scale should be larger there. In their study they implemented a variable-scale map where the scale decreases linearly from the centre of the map towards the edges. This subject has been taking forward in recent years by Harrie (2002) who proposed variable-scale maps for small-display in portable electronic devises. Paradoxically, as it has been reviewed in Chapter 2, mapmakers such as Beck, have been applying variable-scale intuitively for many years and - according to the survey- it is still the most common technique apply in today's Public Transport Maps.



Jenny (2006) analyze the variable-scale of the London Underground diagram using MapAnalyst, a specialized program for computing distortion grids and other types of visualizations that illustrate the geometric accuracy and distortion of maps. According to Jenny this method could help designers of schematic maps to verify their design against the "geometric truth", and guide their choice among different design options.

This kind of maps -usually are referred in literature as *Cartograms*, and has the advantage of integrate large-scale data and small-scale data in the same plan (Monmonier, 1996, Kadmon, 1982; Harrie, 2002). According to Bartram (1980) there is a special tolerance for, and acceptance of, geographical inaccuracy in the representation of the routes of a public transport network, however the uneven distortion of areas can also stress the detachment between maps and reality generating serious problem in travelers recognition and acceptance of geographical inaccuracy such as in 1972 Vignelli's map of the New York Subway System (Chapter 2).

Public Transport Maps as Cartograms

The choice of projection method should match the task or priorities of the intended user of the map. Unique are the maps of public transport systems. In public transport maps there is a strong need for schematization to represent adequately the accumulation of data in the centre of a city (Mijksenaar, 1999).

Cartograms are among the most highly tailored map projections. A great number of Public Transport Maps are linear cartograms that emphasize the importance of linkage instead of geometric accuracy. These maps can have great geometrical distortions, but are usually topologically correct (Harrie,2002).

Linear cartograms display a network in such a way that the length of a connection is related to some characteristic of the connection. In conventional cartographic maps, this length is correlated (through a planar projection of the sphere) to the length of the connection in the real world (Cabello 2004).

Cartographically speaking, a cartogram can be defined as a non-conventional map projection that consciously distorts either area or distance (or both) to reveal patterns not readily apparent on a more traditional base map. According to Monmonier (1996) several traditionalist cartographers tends to consider cartograms "as foolish, inaccurate cartoons" ignoring the power of map distortions in addressing a wide array of communication and analytical needs.

Fidelity and Abstractness ***(Presition & Distortion)***

Although it can be argue that most Public Transport Maps are abstract and distorted representations of routes, there is a large range of representational techniques that can be used to render a transport map with more or less cartographic accuracy. An appropriate rendering style can greatly affect the readability and clarity of a map. Rendering style can also aid the user in interpreting how closely the map corresponds with the real world (Strothotte et alt, 1994).

The pictures on the right show a range of possible forms of depicting transport maps parameterized by the fidelity of the depiction in relation to the physical routes it represents. Fidelity increases from top to bottom (images on the right), or equivalently abstraction decreases and more information is included in the depiction. In order to explain fidelity Agrawala (2002) quote Borges' short story "On the Exactitude of Science (Borges, 1998). Borges takes fidelity to its logical but absurd extreme, describing the perfect map as a 1:1 replica of the Empire that is the size of the Empire.

Graphically, it can be argue that one extreme is represented by conventional cartographic map -also known as city plans or overlay maps- which pretend to keep as much fidelity as possible with the geography. In the other extreme are schematic maps, highly abstract cartograms that abandon geographical relationships, and omit unnecessary details, emphasizing the network connectivity.

In between these two extremes (Cartographic and Schematic) there is a wide range of graphic solutions (also called Hybrid or Semi Schematic maps) in which simplified lines and connections can coexist with main topographic and contextual features.

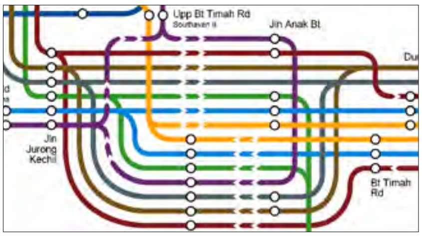
- **Cartographic / Overlay Maps**

Most of this maps have been drawn based on topographic maps and usually apply cartographic scale and projection conventions (Morrison, 1996). Are generally large-scale maps on which the street are shown and named, on which transport routes and stops have been superimposed over a geographical plan (i.e. Mapa Emt. Madrid). These maps can carry comprehensive information, especially about the transport routes in relation to streets, landmarks and other physical features; but they can also become overloaded with information and difficult to read (Denmak, 2000).

- **Schematic Maps**

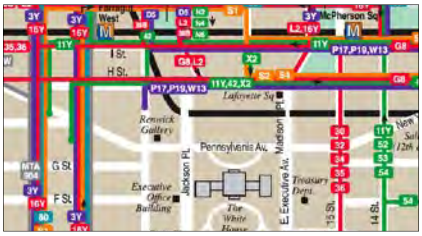
Schematic maps are highly generalized maps used for representing routes in transport system or in any scenario in which stream of objects at nodes in a network play a role (Avelar et alt.). Schematic maps strip the information down to the bare essentials and can give a quick overview of the route and its main features. However, because they are not based on actual distances or even directions they hinder passengers relating to the real geography of the area. "Not To Scale" can mean that distances can be very distorted. Morrison (1996) define Schematic maps for Public Transportation as one which has all transport lines drawn as straight lines which are horizontal, vertical, or at 45 degreers (i.e. SL Spartrafik, Stockolm).

SL Spartrafik, Stockolm. Sweeden



Bukit Batok SsMRT Bus & MRT Sservices. Singapore

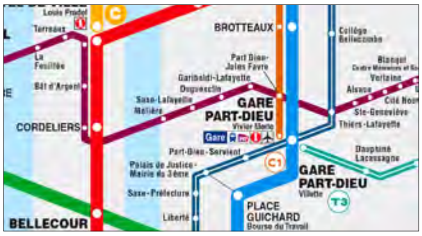
BVB Liniennetz Basel und Umgebung. Basilea.



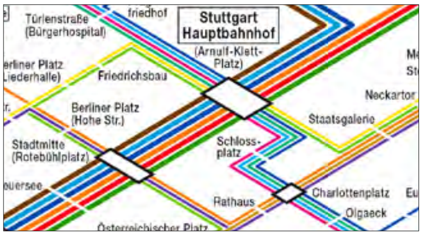
Metro Oopen Doors. Washington D.C.. USA

GgMPpTEe Nnetwork, Manchester. UK

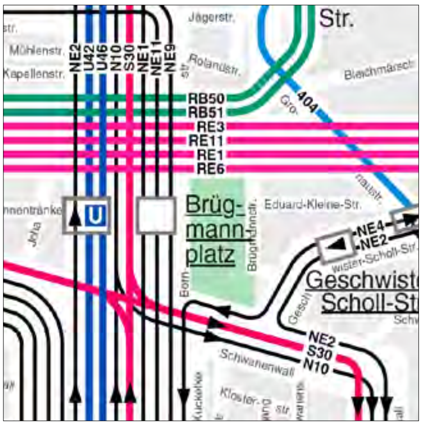
Mapa Emt. Madrid. Spain



TCL Métro - Tramway - Cristalis; MTC. Lyon. France. Probably the only transport map that use diagonals at 20°.



VVS, Verbund - Schienennetz. Stuttgart. Germany. This map use only diagonals at 30° without vertical or horizontal lines.



Rhein-Ruhr, Linienplan Dortmund. Germany

Sometimes the lines may be at 0, 30, 60 and 90 degrees. (Morrison, 1996). The use of fixed angles in corner points can certainly give a visual consistency and improve the legibility of texts but almost inescapable accentuate the distortion and detachment of the map with topographic reality (Denmark, 2000).

The straight lines at fixed angles can also suggest that schematic maps are in some way automatically drawn by a computer, however, most of the time these maps are projected by designer through a mental process, which involve many tries and error and arbitrary decisions. Recent research has been devoted to establish automatic methods to generate and query schematic maps (Avelar and Müller, 2000; Avelar and Huber, 2001, etc.) but until today most of the design process in Public Transport Maps has depended in the ability of mapmakers to capture the topological pattern of the network.

A main design disadvantage with schematic maps relates with its production and edition. Even when a small route change occurs, it may involve the re-design of a substantial surrounded area or the whole map. In exchange, since there is less information on a this maps it may be possible to reduce the size of the print used or enlarge the text (Denmark, 2000).

Hybrid –Semi Schematic

Hybrid maps are graphic compromise between cartographic and schematic maps.In general, *hybrid* maps show background detail, for the purpose of general location, and include some streets or main avenues. Are maps on which the whole of the routes of the network are easily distinguished and followed, so that users can see which line to take, in which direction, and where to change lines. To keep clarity this maps often integrate several services in few lines (Morrison's French style) and apply variable-scale distortion moderately.

The increasing interest for "hybrid" forms of maps such as the Delf-Mijkseenar, Quick Map, and Kick maps (Chapter 2) seems to mark a trend towards a new perception of Public Transport Maps from the point of view of independent users. At the same time factors such as the growing complexity of transport systems, the integration of networks (i.e. intermodal systems) and the conurbation of large cities are stressing the capability of both, schematic and cartographic projection. In this context, more flexible projections –such as "hybrid" maps- might facilitate the introduction of more information without tensioning its design process and users capabilities.

Morrison (1996) describe the map for the Rhine-Ruhr conurbation (Bochum, Dortmund) as on of the most outstanding example of a conscious compromise solution to this kind of map. In designing these maps, bus services are inserted first using generalized straight lines (without fixed angles). As the lines are 2mm apart, the streets may by up to 16mm wide. If necessary the crowded areas are made larger by judgment using *"eye and brain"*, not by mathematical projection. Then all the streets not followed by buses are "adjusted" to fit into spaces between the bus routes, so that 95% of all streets are named (ibid).

6.2 GRAPHIC LEVEL *(Symbolization)*

One interesting aspect that arise analyzing the cases of New York and London refers to the importance of symbolization. Even so far most of the discussion on these maps has focused in their graphic structure (Schematic versus Cartographic projection), a deeper review of both cases shows that users understanding of symbols (i.e. Interchange Stations) and other graphic operations can be determinant in the function of maps (Bronzaft et alt. 1976).

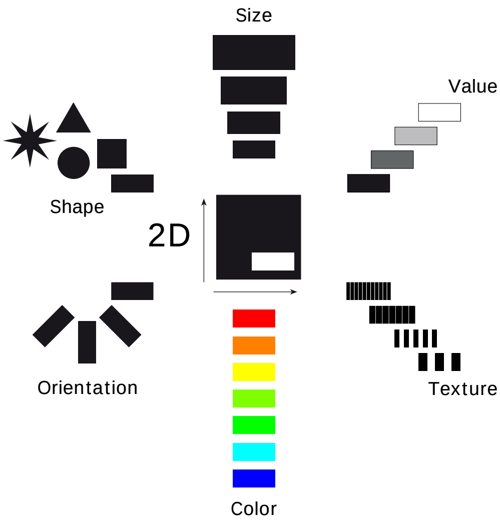
Map Symbols

To understand the logic of map symbols begins with recognizing the three geometric categories of map symbols and the visual variables that determine them. Symbols on flat maps are either *Point Symbols, Lines Symbols or Area Symbols* (Monmonier, 1996). Generally Public Transport Maps use a combinations of all three: *Point Symbols* marking the location of stations and other landmarks, *Line Symbols*, which show the lengths of the routes connecting stations and sometimes *Area Symbols* that depict the form and size of some geographical references (i.e. lakes, parks, mountains, etc.) and service zones (Monmonier 1996; Avelar et alt., 2006). These graphic symbols in static maps can differ in size, shape, graytone, value, texture, and hue (color). It must be acknowledge that location has not been depicted explicitly here as a visual variable, since it refers to the position of individual symbols and therefore it is an inherent part of mapping.

Visual Variables

Visual variables is a concept commonly used to describe the various perceived differences in map symbols that are used to represent geographic phenomena. The notion of visual variables was first developed by the French cartographer Jacques Bertin (1967) and further adapted by others, including McCleary (1983), Morrison (1984), DiBiase et al. (1991), and MacEachren (1994a).

On route maps visual variables can indicate orientation to show direction of movement, size (thickness) to show relative importance, shape to distinguish different kind of stations and landmarks; and greytone value to provide contrast among background features and routes. Some times textures are also considered to distinguish routes of different types.

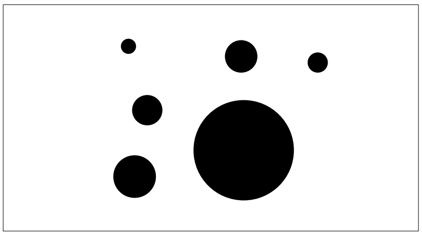


Bertin's arrangement of graphic variables: Position, Shape (form), Size, Value (contrast), Texture (grain), Color, and Orientation (direction).

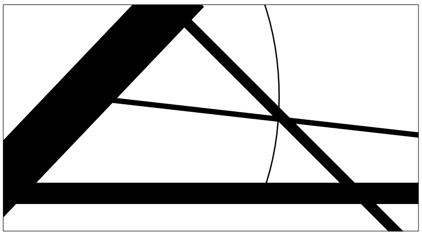
•Size

Refers to the change in the visual differences in the size of the entire symbol, as is shown for the point and linear phenomena. For areal phenomena, the size of the entire areal unit could also be changed, as is done on cartograms.

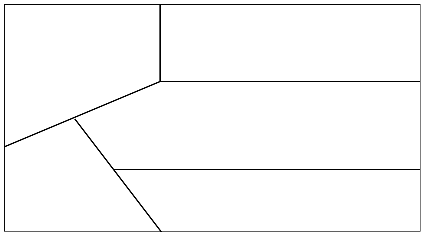
Point Symbols



Line Symbols



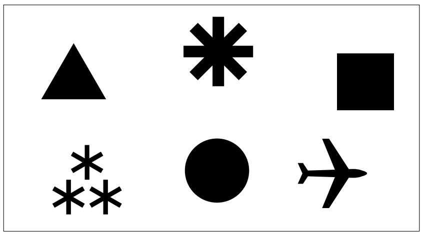
Area Symbols



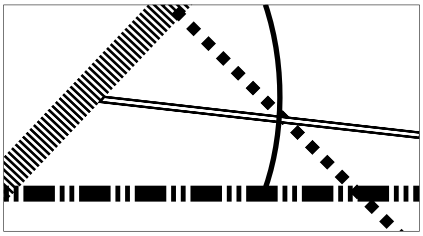
•Shape

Refers to the graphic form of the symbol. Similar to the orientation varaible linear and areal shape refers to the form of individual marks making up the symbol. For point phenomena, shape refers to the form of the entire point symbol. A major group of point symbols are pictographic symbols, which are intended to look like the phenomenon being mapped (as opposed to geometric symbols such as circles).

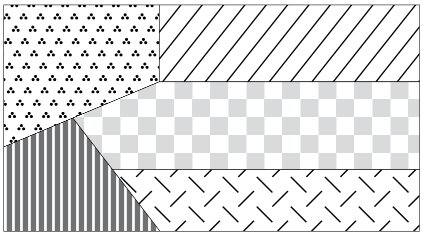
Point Symbols



Line Symbols



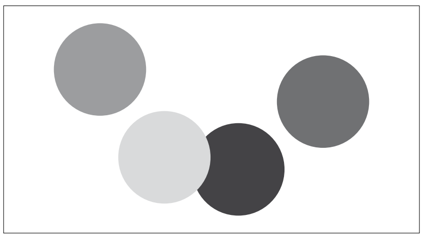
Area Symbols



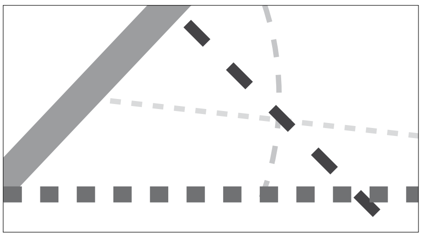
•Greytone Value /Arrangement

For point and areal phenomena, note that arrangement refers to how marks making up the symbol are distributed (i.e. ink dot per inch, *dpi*). For linear phenomena, greytone/arrangement can also refers to splitting lines into a series of dots and dashes, as might be found on a map of political-administrative boundaries.

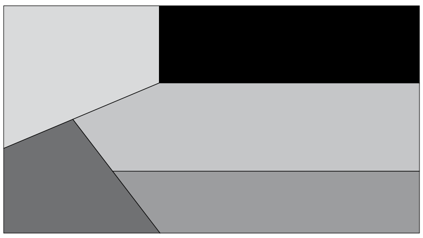
Point Symbols



Line Symbols



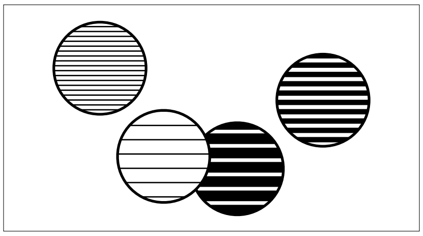
Area Symbols



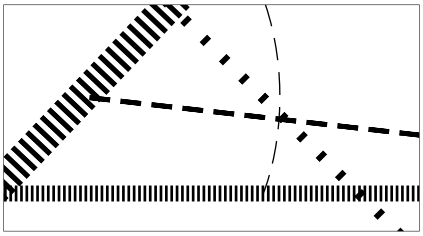
•Texture or Spacing

The spacing visual variable involves changes in the distance between the marks making up the symbol. Cartographers traditionally have used the term texture to describe these changes (e.g., Castner and Robinson 1969), but Slocum et al. (2004) use the term *spacing* because texture has different usages in the literature.

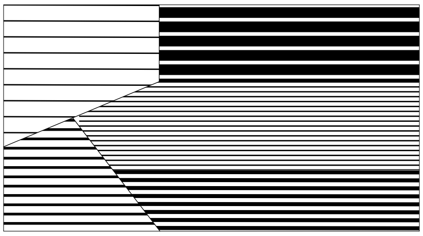
Point Symbols



Line Symbols



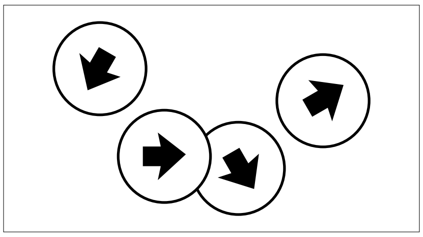
Area Symbols



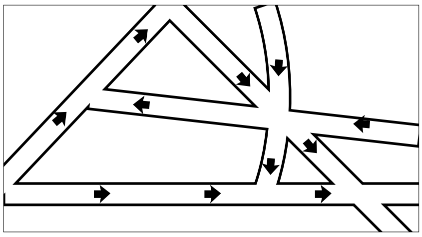
•Orientation

For linear, areal orientation refers to the direction of individual marks making up the symbol. In contrast, for point phenomena, orientation refers to the direction of the entire point symbol (Marks of differing direction could be applied to point symbols, but the small size of point symbols often makes it difficult to see the marks.) Orientation is an important visual variable for symbols that represent features with identifiable direction, such as lines and arrows portraying roads sense.

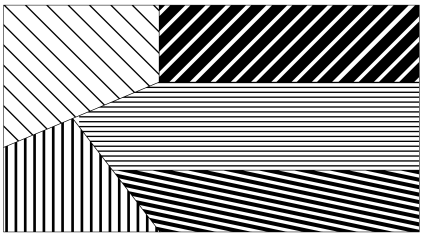
Point Symbols



Line Symbols



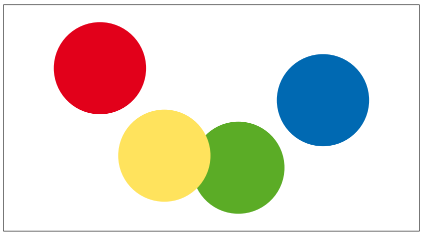
Area Symbols



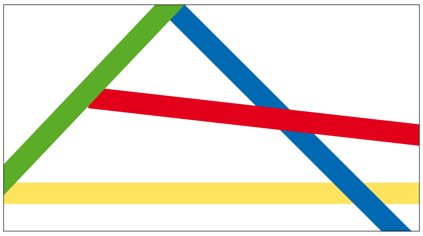
•Hue, Lightness, and Saturation

The visual variables hue, lightness, and saturation are commonly recognized as basic components of color. In everyday life, hue is the parameter of color most often used. Lightness (or value) refers to how dark or light a paricular color is, while holding hue constant. Lightness also can be shown as shades of gray (in the absence of what we commonly would call color).

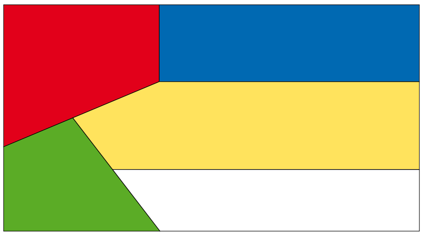
Point Symbols



Line Symbols



Area Symbols

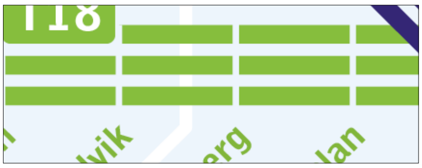


Symbols and Visual Variables in Public Transport Maps

Graphic symbols in Public Transport Maps varied from map to map. However, the recurrence of certain shapes and graphic solutions allows the identification of certain categories and features, specially in points and lines, probably the most relevant symbols in this kind of maps. The attributes of these symbols may encompass all level of representation and most visual variables such as size, shape, texture and colour (Avelar, 2006; Kennedy, 1999; Monmonier, 1993).

Sydney CityRail Network.

Hamburg, Rapid TransitRegional Train.



Linjenätskarta Tunnelbana, Stockolm.

RomaMetroPerMetro.

Bussilinjar, Helsinki.

Lijnennetkaart, Amsterdam.

London Tube Diagram. Gloucester Road and South Kensington Stations.

• Point Symbols

(See also Annex 1 with a complete inventory of Point Symbols in Public Transport Maps)

Point symbols not only mark specific locations in map, but often also describe one or more attributes of this location (Monmonier, 1993). In a Public Transport Map when point symbols take place over a line they generally represent a detention in the service. Most of the time this detention can stand for an stations, interchange station or a terminal and its distinction depends mainly on it size, its shape and color.

- Stops & Stations: These symbols - mainly use in schematic maps- are usually small interventions on/in the line and in most cases do not alter the continuity of the line. An exceptions is the *"Gap"* Stations, which cut the line in different segments (i.e. Stockolm's Linjenätskarta Tunnelbana). Some times station symbols can also represent the sides where doors are expected to open as in the case of Lijnennetkaart in Amsterdam.

Few bus maps use this symbols, probably because the display of numerous "stops" along the route could jeopardize the map clarity. If used, these symbols are usually located aside the line, showing the position of the shelter (bus flag) in relation with the route (Bussilinjar, Helsinki).

Eventually, more than one line can coincide (*"stop"*) in the same station. Generally this happens when different services share the same railway or street. This situation can create confusion with Interchange Stations as in the case of Gloucester Road and South Kensington Stations in the London underground map.

The application of this "stop" marks in the maps observed in the survey allow can be summarize in the following typology:

- *Ticks* (i.e. Sydney, CityRail Network).
- *In-line ticks* (i.e. Hamburg, Rapid TransitRegional Train).
- *Gaps* (i.e. Linjenätskarta Tunnelbana, Stockolm).
- *Rosary* (i.e. RomaMetroPerMetro).
- *Aside Signs* (i.e. Bussilinjar, Helsinki).
- *Door Open* (i.e. Lijnennetkaart, Amsterdam).

- Interchange Stations: Generally represents the mayor nodes of the network, where lines and modes connect. Most of these symbols are usually close forms and can vary its shape; size and color depending on the number of lines it connect. Often, Interchange Stations are magnifications or variation of simple Stations. In other cases they can became a whole area, a distinctive symbol –such as a logotype- or adapt its form according to the lines involved in the connection.

- *Ring:*
  - *Rings Connected*
  - *Ring Stressed* (i.e. Barcelona Metro).
  - *Concentric Rings*
- *Dot* (i.e. Lyon, Agglomération).
- *Polygon*:
  - *Regular*
  - *Irregular* (i.e. Metro Tokyo).
- *Color:*
  - *Pie* (i.e. Metro Mexico City).
  - *Overprint*
- *Area* (i.e. Paris Bus map).
- *Pictogram* (Transantiago. Santiago).
- *Blank Space* (i.e. VVS, Verbund Schienennetzork. Stuttgart).
- *String* (i.e. Hannover, Busnetz).

- ***Terminal:*** Can represent both, the end and the start of the line and generally take the form of Station or Interchange Stations. Commonly Terminus name are highlighted to facilitate the service direction (i.e. Paris Bus map, Hannover, Busnetz).

• Line Symbols

Different than point symbols, line symbols have not only location but also the dimension of length (Monmonier, 1993). In Public Transport Maps a line stand for a route or routes and can simultaneously represent transport modes, services and some time temporal attributes (i.e. express or night services). Lines can also be use to represent streets and main Avenues. These symbols can take advantage of most visual variables such as size, color, value, shape, texture and direction.

- ***Line Size (thickness):*** In general lines in Public Transport Maps preserve its weight throughout the whole route. Differences in thickness between two or more lines are generally used to differentiate transport modes or to contrast hierarchy among services. Most of the time metro's lines are represented wider than other modes. In bus maps one line can usually represent more than one service without changing it appearance. Depending on the size, events in line symbols can occur inline and outline (i.e. Lyon, Agglomération map).

-***Line Color/Value:*** Colors coding is a map dilemma; it can help or hurt a map and its interpretation (Monmonier,1996). Most of the time, the assignation of color to lines is the best way to differentiate services and modes in Public Transport Maps. Color attributes can be very effective to distinguish small numbers of lines (beteween 9 and 12). However these numbers can become very limited when it is use to identify larger numbers of services, especially when many lines intersect or share the same route (i.e. Maimi, Transit Integrated System).

Detail, Maimi, Transit Integrated System

Barcelona Metro

Lyon, Agglomération

Metro Tokyo

Metro Mexico City.

Paris Bus map

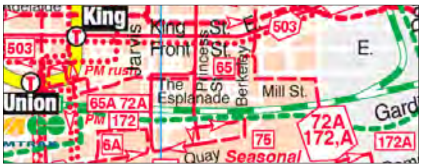
Transantiago. Santiago

VVS, Verbund Schienennetzork. Stuttgart

Hannover, Busnetz

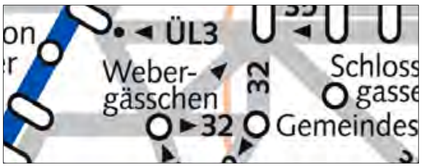
Taipei, City Bus Route Map

Frankfurt Schnellbahnplan. Rhein-Main-Vverkehrsverbund

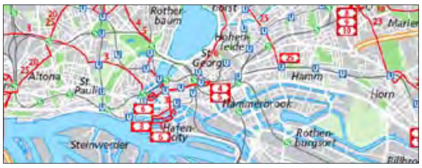


TTC Map, Toronto.

Linjenätskarta Tunnelbana, Stockolm.



Basel Liniennetz.



Hamburg HVVvv Metro Buses.

Porto Metro.

Brasilia Metro.

Cain's survey (2007) done with several American Transit Agency demostrate that the number of colors used in Public Transport Maps varies widely, ranging from only two colors up to 32 colors. The sample average was calculated to be 13 colors, which is higher than the maximum of nine colors recommended in in most literature.

The recognition of hues among other contiguous lines (i.e. Taipei, City Bus Route Map) and its discrimination against background colors (i.e. yellow lines over a white background) are among the most difficult challenges when dealing with color codification. The use of a regular gap between parallel lines, as well as the use of outlines or a case can contribute to lines' recognition, isolating paths from its context (i.e. Frankfurt Sschnellbahnplan. Rhein-Main-Vverkehrsverbund).

-Line Textures: Line symbols can also be composed of string of tiny point symbols that vary in shape and texture (Monmonier, 1993). Like colors, textures can contribute to lines recognition and are commonly use to characterize different transport modes (i.e. Toronto's TTC Map). Additionally, textures can be complemented with colors increasing their representational possibilities. Often textured lines represent temporal attributes for example the use of dotted and segmented lines to represent possible detours, a line under construction or future routes (i.e. yellow line in Milano's Metro map). The use of texture lines can also be very effective in monochromatic version of maps offered by some transport systems to facilitate it reproduction with black and white laser printers.

-Line Direction: Since a Line Symbol in a Public Transport Map generally represent routes, it often require graphic marks to indicate direction (Kennedy, 1999). In most cases the sense of direction is usually represented displaying numbers alongside the lines. However, some time this operation is not enough to indicate the right direction of a route, especially when a service follows different paths in its way back. In these cases the use of direction arrows and other graphic marks are used to indicate the route course (i.e. Basel Liniennetz).

- **Area Symbols**

Area symbol are usually consider as the background of the map and allow the map-reader both identify zone at a particular location, and see its extent. In some maps -specially on scale maps- area symbols often represent topographic features as well as build-up areas, and administrative regions (Phillips, 1980). One example is Hamburg HVVvv Metro Buses.

But area symbols can also play different roles on public Transport maps. When not representing topographic features most of the time area symbols depict pay-zones (i.e. Porto's Metro), operator's jurisdiction (i.e. Santiago), day and night services (i.e. Zurich), or even corporative identity (i.e. Singapore). Most typically, color codes are used to differentiate these classes of information.

In general area symbols, in this kind of maps use flat colors in lighter hues to contrast evenly with the rest of the maps symbols and labels. The use of bright and saturated colors can jeopardize the discrimination of information and the legibility of the maps such as in the case of Brasilia metro map. Less commonly, areas are coded by visual textures such as dots or stripes (i.e. Melbourn). Sometimes color codes and texture codes are used in combination.

6.3 TYPOGRAPHIC LEVEL (Map Lettering)

Typography can be define as the art and methods of arranging type, type design, and modifying type glyphs. Type glyphs are created and modified using a variety of illustration techniques. The arrangement of type involves the selection of typefaces, point size, line length, leading (line spacing), letter-spacing (tracking), style, effects, and kerning.

The application of languages labels to maps is a basic part of map design. In this context map lettering refers to the selection of type and its placement on the map (Dent, 1993). In traditional typography, text is composed to create a readable, coherent, and visually satisfying whole that works invisibly, without the awareness of the reader. Even distribution with a minimum of distractions and anomalies are aimed at producing clarity and transparency.

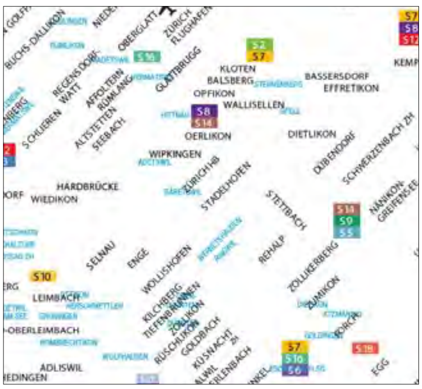
As Phillips (1977) stressed, map lettering has always been a challenge in mapmaking. Typography for cartography can be more complicated than traditional typography because of complex text placement and potential density of features, visual hierarchy, overall look and feel, the fact that text often represent features as symbols in their own right, and the interplay between text and other multi-layered map features such as symbols, background colors, and textures (i.e. Lille's Transpole Map and Zurich ZVV S-Bahn, Zurich). However, the overall goal of legibility and readability remains the same of traditional typography applications such as in book design (Saligoe-Simmel, 2009).

Transpole Map, Lille.

Unlike most books, however, maps are multi-layered, complex compositions. According to type designer Felix Arnold (1999) the uppermost layer of type often contains the most important information, but must remain legible without covering over too much of the visual detail underneath. Arnold (ibid.) lists several ways in which cartography differs from traditional typography:

- On maps and plans, text competes with the graphics. In books and magazines, they normally work alongside one another. Text on maps or plans may include place names, descriptions, additional political or geographic info, elevation, and coordinate points.
- Cartographic text cannot be placed over backgrounds that share the same color as the letters.
- Cartographic text is also typically placed over many various types of backgrounds – which are usually dark - instead of a common white background, as is the cast with traditional text-based documents.
- Small text can be difficult to read when placed over complex, textured backgrounds.
- The eye reads text on a map letter-by-letter, instead of through word shapes.
- On maps, single lines of text often run across the page diagonally, or on a curve.
- Type size and style changes quite a lot on maps.
- Much map text is set in quite small point sizes.

ZVV S-Bahn, Zurich



ZVV S-Bahn, Zurich. Typographic layer

• **Map Lettering Goals**

Hodgkiss (1966) delineate four major goals, that a mapmaker should keep in mind while approaching map lettering:

- Legibility
Legibility research traditionally deals with the characteristics of letter design and how they affect the speed and accuracy of reading. Because lettering on maps usually occurs in a much more complex environment, legibility is achieved not only by choosing the appropriate typeface, but also by attending to good placement, adequate spacing of letters and words, and lettering environments such as background textures and confusing line-work.

- Harmony
Lettering harmony involves several features related to the selection of a typeface -specially regarding its contrast. Some professional cartographers hold that only one typeface should be used on the map. To achieve con trast and harmony, the cartographer may, however, select several variants of a single type family (Robinson, 1966). According to Hodgkiss, the preferred way of mixing type is to vary roman and italic forms in the same family and to vary weight (light, medium, or bold).

- Suitability of reproduction
Refers to the character of the typeface and how well it stands up to reduction and printing. Typefaces containing small bowls and counters tend to "close up" during printing, especially if excessive ink is used. Styles with unusually thin strokes and serifs may not print well; these letter features may disappear during printing. The designer should evaluate how well each letter in a proposed style will reproduce in the job at hand.

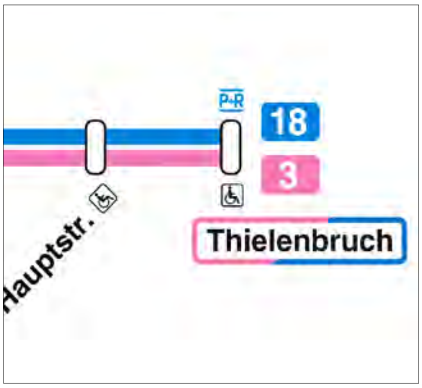
- Economy and ease of execution
More than four decades have passed since Hodgkiss wrote these goals and type design and printing reproduction technologies have changed substantially since then. However, designer still needs to evaluate the cost of lettering, especially when selecting especial or customised typefaces (rather than generic fonts) since are protected by copyrights. Thus, the license cost of a complete family can be a decisive factor in the digital context.

• **Empirical Studies**

For several years empirical studies have approached map lettering. The research of J. Phillips, L. Noyes, R. Audley, B.S. Bartz, and others, on human factors in maps reading are seminal. The compilation of these studies along typographic practice and cartographic conventions aloud the organization of general guidelines regarding the use and performance of type in maps such as the selection of typefaces, the use of capitals and lowercase, lettering placement among other issues.

The utility of these studies is evident, however, the challenge for mapmakers persist, particular with special purpose maps such as Public Transport Maps- since the demands on users and the reading conditions are very different from other types of display. Usually, these maps imply the repetition of text elements -such as as route numbers- through different stages of a route., therefore the multiplication of texts and its irregular distribution through the plan.

Stimulated by the improvement of their services, important transport agencies - especially in the US and UK- have included some aspects about map lettering in their users' studies (i.e. Cain, 2004 & 2007). Although these researches identified interesting problems in reading transport maps, most conclusions and guides are extremely general and therefore not necessarily usefull for mapmakers.

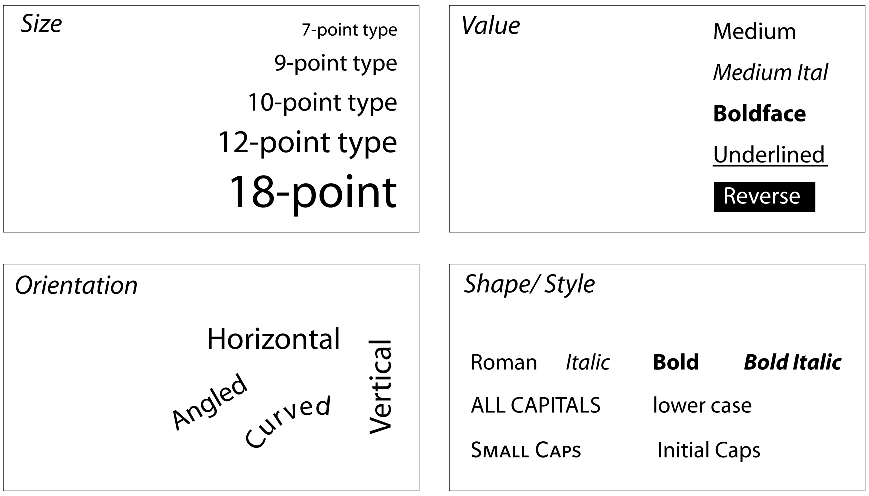


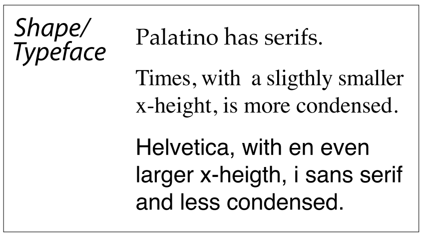
Koln, Schnellverkehr Vverkehrsverbund Rhein-Ssieg

• **Map Lettering as a cartographic Symbol**

Although Bertin's theory of visual variables does not address type directly, to many authors, map lettering should be viewed as a functional symbol on the map (Dent, 1993; Slocum et al.,2004; Monmonier,1993, 1996; Robinson, 1952; etc). For instance visual variables allows labels to code features by kind and class as well as by name. For instance the text on a terminal station (i.e. Koln's *Thielenbruch*), in which the label attaches a unique name to a point symbol that represents a main station, the size and style of the type reinforces the primary graphic code of the point symbol.

According to Monmonier understanding visual variables of type is important, because labels should reinforce, not contradict the map's symbology. Monmonier (1991) extend this idea explaining how typographic variations reflect several Bertin's visual variables.





According Monmonier's interpretation common typographic variations reflect several of Bertin's retinal variables.

Letterform features, sizes, and styles available in a typeface provide the map author with a variety of visual variables to portray qualitative or quantitative differences among features identified by name. As with the point, line, and area symbols examined before, type favors some visual variables more than others.

Monmonier recognize straightforward matches for orientation and size, a somewhat forced match for value, and a rich assortment of variations in shape. In his attempt to match common typographic variations to Bertin's six retinal variables Monmonier omits hue, because legibility requires a strong contrast between a label and its background. However, as it will be explore later, color type play an important coding role in Public Transport Map.

This interpretation of visual variables also omits *texture*, because variation in the spacing of letters interferes with reading and is a poor way to portray either quantitative or qualitative differences. Moreover, although the *value* variations suggest a number of strategies for using darker type to emphasize important features, these examples also vary in shape and size (thickness) and do not form a progressive series.

Raitiolinjat ja keskustan bussilinjoja; Keskusta. Helsinki

AA

Arial Regular 110 pts | Bell Centennial Address 110 pts.

22

Arial Regular 110 pts | Bell Centennial Address 110 pts.

:: This line of text is setted in Arial 6 typographic points.

:: This line of text is setted in Bell Centennial 6 typographic points.

Arial Regular 6 pts | Bell Centennial Address 6 pts.

Labels varying in gray tone or in color percentage are likely to be illegible or difficult to distinguish from each other.

Monmonier's adaptation of Bertin's visual variables has been consider here as a framework to analyze particular aspects of lettering in Public Transport Maps:

Type Size

Generally speaking, type size should correspond with the size or importance of map features. If the type size is carefully planned, the hierarchy should be apparent to the map-reader. For example type representing the names of large interchange station could be noticeably larger than type used to represent a secondary landmark (Slocum et al. 2004).

This does not suggest that label sizes are proportional to the sizes of features, but rather that there should be an ordinal association (i.e. Helsinki's Raitiolinjat ja keskustan bussilinjoja; Keskusta). Shortridge (1979) observe that users are not sensitive to slight differences in type sizes and Hodgkiss (1966) suggest that rarely should there be more than four to six different sizes.

All type in a Public Transport Map should be readable by the intended audience. Factors for consideration include the age and visual acuity of the map user, map reproduction method, anticipated lighting conditions, and the map user's physical proximity to the map.

For users of Public Transport Maps type size is consider among the most critical factor (Cain, 2007). Most of the tests done by transport agencies on travelers information needs focused in this aspect.; particularly in determining the minimal size of a typeface.

For instant Higgins and Koppa's report (1999) which consider elderly people and people with visual disabilities as a significant segment of transit ridership-recommended a 10-point minimum font size for text on maps and other printed materials. Another report from the United Kingdom (ITSC, 2002) stated that a 14-point or larger font size was preferable, but that under no circumstances should a font size be lower than 8-point.

However the disparity between users center studies and mapmakers options are evident in Cain's survey (2007) which provides a summary of the minimum font sizes used on the system maps of 121 different transport agencies in the US. The analysis found that minimum font sizes ranged from 2 point up to 10-point, with 6-point being the most common font-size. The sample average was of 6.3-point.

The scarce agreement of mapmakers to these guidelines reflects inconsistencies in such a studies. For example, most of these tests consider the point size of a typeface as an absolute index, overlooking some basic typographic notions. For instance two different typefaces with the same point size can have completely different x-heights and diverse performances. In fact, there are many typefaces intended for being printed in small sizes that might be more legible than other fonts set in larger point size. (i.e, Cisalpin, Bell centennial, TS Mapa,) The design of these typefaces resolve particular perceptive and printing questions that enhance the legibility of letterforms (i.e. ink traps).

Another aspects that is not necessarily contemplated in transport users' studies relate with the eventual impact of increasing the minimum size of typefaces in the final format of a map. In most cases the size of a map is directly proportional with the type size. Larger type might require more space, therefore an adjustment in the size of the overall map. Considering that Public Transport Maps are generally used in odd traveling conditions the size of a map could be consider more determinant for users than its type size. Nevertheless, further studies should be done regarding this subject.

There is no doubt that a compromise between the users need tests and mapmaker's options could improve the performance of Public Transport Maps. Cain's research concluded that regarding the minimum size of a type in maps the majority of US transport agencies are already using the optimum design options.

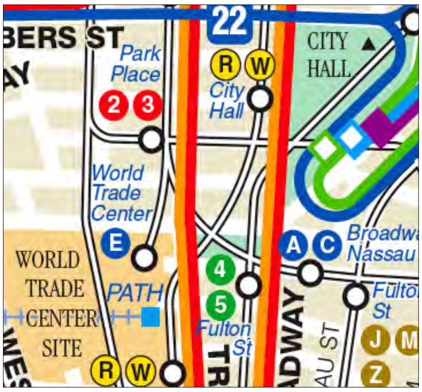
Certainly the size of a typeface can affect the reading speed (Phillips et alt. 1977) but does not seem to be essential to successful trip planning. (Cain, 2004) According to Slocum et al. (2004) readability in maps is ultimately tied to the typeface used, crispness of reproduction, and other factors; and the only way to ensure the readability of small type is to provide sample to members of the intended audience.

Type Shape/Typeface

The selection of the typeface for a map requires careful inspection of each letter in the font. Ideally it has to be very legible at small sizes so, features such as: good contrast, large/open counters, ample lowercase x-heights and distinctive character shapes are desirable.

Each letterform in the typographic family has to be optimized so that they cannot be easily mistaken for another (Arnold, 1999). For example in Public Transport Maps special attention should be put in key letters and numbers that share similar morphology such as 3-8; I-1-l; C-o-O-Q; 9-6 among others. If the typeface is not properly selected these letterforms can be easily confuse and could determine -for example- the correct or incorrect recognition of a bus number or a destination.

Arial	TS Mapa
3 8 I 1 l	3 8 I 1 l
C 0 O Q	C 0 O Q
96 69	96 69
Arial Regular 30 pts	TS Mapa Regular 30 pts
I010IO3838I1QC8I1I0IO383I1QC0O	I010lO3838I1QC8I1l0lO383I1QC0O
35.24 mm	30.04 mm
Arial Regular 6 pts.	TS Mapa Regular 6 pts.



MTA Manhattan Bus Map. New York.

The selection of a typeface with tabular and mono-spatial numbers could also simplify the composition and its recognition on maps since they provide a more homogeneous treatment of the forms. Oldstyle or non–aligned numbers which has descendent and ascendent strokes do not seems suitable for this kind of maps where numbers fulfill an identification role.

Research conducted by transport agencies regarding the selection of proper typefaces for public transportation material, usually focused the scope of their studies in the differences between *serif* and *sans-serif* typefaces. While Cain (2007) recommend the use of *sans-serif* fonts for all labeling and short word series, *sans-serif* fonts, Higgins & Koppa (1999) state that *serif* fonts should be used for longer blocks of text. Although limiting the research to this aspect seems rather partial, it is interesting to observe that almost all of the 133 maps analyzed for this thesis were set in *sans serif* typefaces. Few cases –instead-use more than two type families on a given map. For example the map for the Manhattan bus system combine *serif* and *sans-serif* fonts with different purpose. While *sans serif* family is used for service numbers and main labels, a *serif* family is used for a secondary category of features (i.e. Important building and landmarks). Simpler maps can be limited to one type family.

Transit

Transit, designed by Erik Spiekermann for Berlin's transport system. 1991.

Parisine

Parisine, designed by Jean-François Porchez for the Paris' transport system RAR. 1996.

Vialog

Vialog, designWerner Schneider & Helmut Ness for Munich's transport system. 2002.

TS System

TS System, designed by Rodrigo Ramírez y Francisco Gálvez for Santiago de Chile transport system. 2006

Another interesting finding regard the increasing number of customizes fonts families designed specifically for transport systems. This trend, originally initiated by Johnston's font for the London Underground *Johnston* (1917) and then followed by Frutiger's *Métro* (Paris, 1973), Rathousky's *Metron* (Prague, 1972), Unger's *M.O.L.* (Amsterdam, 1974), Spiekerman's *Transit* (Berlin,1991) and Porchez's *Parisine* (Paris, 1996) seems to be rapidly expanding through different systems worldwide. (i.e. *TS System* for Santiago, *Metropolis* for Lisbon, *Vialog* for Munich)

Some of this type families have versions specifically done for map's reproduction and are aimed to improve users' reading in irregular reading condition (small sizes, paper and printing quality, uneven light, etc). If used properly these fonts can also add recognition, consistency and value to the transport system.

According to typographer Felix Arnold (2004), a proper typeface for a map must meet the following standards:

• The typeface must be legible in small sizes.

• At the same time, the typeface must also be slightly narrow, to avoid line lengths running too long.

• The different styles and weights of the typeface must be clearly differentiated from one another.

• Individual letters must also all appear different from one another, to help minimize misreading and misunderstandings.

• The typeface must be able to form good word shapes, which will also directly increase legibility

It must be acknowledge, though, that the design of several maps registered in the survey has been quite stable in time using more conventional typographies such as Frutiger or Helvetica. In fact, it can be argue that Helvetica Medium has became for New York Transport system what Johnston has signified for Transport for London.

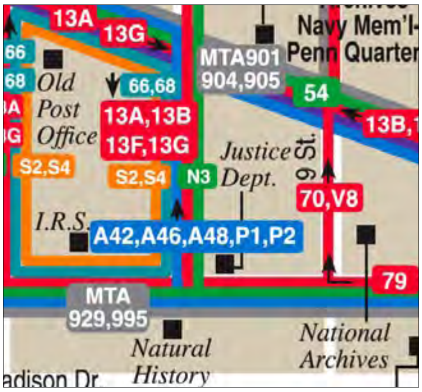
Type Value - Variation

Using only type of different weights in one family should not be considered a limitation in design. Variations within a family can offer sufficient variety for all but the most complex maps. Difference in weights, if used effectively, can be very expressive. Weights should be chosen in accordance with the importance of the feature the lettering identifies (Slocum et al. 2004). Diverse weights, though, should be clearly differentiated from one another to avoid misinterpretations.

Regarding to the conventional use of italic/oblique type in cartography, this style has been reserved for two applications: to label hydrographic (water) features, and to identity publications in the data source. Italics are appropriate for hydrographic features because their slanted form resembles the flow of water (it is also conventional to use the color cyan for hydrographic labels and features). The use of italics for publications is a standard in bibliographic practice (Slocum et al. 2004), however, the wide variety of features on maps might require that the use italic styles outside of these conventions. For example, labeling a service with a number a italic can identified night services or other special feature such as “work in progress”. (i.e. Koln’s Schnellverkehr Verkehrsverbund Rhein-Sieg map).

MVV Verkehrslinienplan Sstadt, Munich.

Type variations in the weight and style of texts and numbers are often utilized in Public Transport Maps to differentiate the hierarchy of stations, services, landmarks and other features. Often American transport Maps use text in italic to identify landmarks (i.e. Washington D.C. Metro Open Doors). However, the overuse of multiple weights (specially, demi bold and black) can overshadow other map elements, and is normally not required if appropriate type sizes are chosen (Slocum et al. 2004).



Metro Open Doors, Washington D.C.

Type Shape/ Style

Good lettering design on the map can be achieved by contrast of capitals and lowercase. A map that contains only one form or the other is exceptionally dull and usually indicates a lack of planning (Dent, 1993).

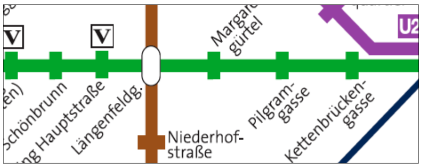
According to Monmonier’s interpretation the concept of Shape/Style mainly refers to the use of capitals or uppercase and lowercase. Both lettercases are used in cartography, but lowercase letters have proven to be easier to read (Phillips, 1979). This is because lowercase letters are less ‘blocky’, and they provide more detail that helps differentiate one better from another.

Words set in all uppercase are sometimes used as short titles and as labels for areal features.In general, capitals are used to label larger features such as Cities, Counties, Neighborhoods, and important items such as large Interchange Stations, Terminals, and perhaps important landmarks (i.e. a lake or a mountain range). Capitals might be also use to mark a difference between to similar labels with different features.

Metro (Los Angeles County Metropolitan Transportation Authority) System Map

TPG Transports Publics Genevois.

According to Slocum et al. (2004) and general typographic practice the majority of type on a map should be composed of lowercase letters with the first letter of each word set in uppercase. This is usually known as “title case”. Conjunctions and other “linking words” (in, on, or, of, per, by, for, with, the, and, over, etc.) are set in lowercase. Title case is appropriate for use in titles, subtitles, legend headings, legend definitions, labels for point and line features, and so on.

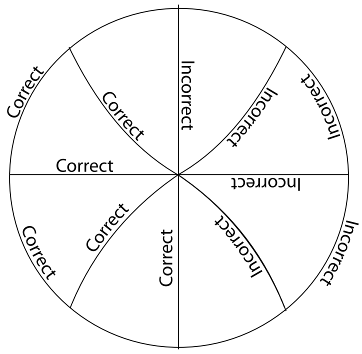


Der Plan Der Schnelisten Wege. Vienna.

Metro a autobusy Ppraszke integrovane dopravy. prague

Verkehrslinienplan Stadt. Munich.

Bus Map. Paris.



Type should be placed uprigth and should read from left to right. Vertical Type should be readable from the right side of a page.

A human factor research done by Phillips et alt. (1978) entitle “searching for names in Maps” conclude that place-name labels set in this form (lowercase type with initial capitals) are more easily recognized and more rapidly located than uppercase place-name label.

Type Orientation

In general type in map should be oriented horizontally. Some exception may apply, though, when labeling diagonal or curved linear and areal features, in which case the type should reflect the orientation of the features (Slocum et al. 2004). This is the case of many transport maps where labels must follow the path of services considering different angles.

The orientation of type in a map might become straightforward in transport diagram with fixed angle such as 0º, 45º, 90º(i.e. Vienna’s Der Plan Der Schnelisten Wege). However some designers seems to have a stubborn position regarding type orientation in these cases. For example designer Erik Spiekerman, sustains that type orientation on transit diagrams has to be horizontal (i.e. Prague’s Metro a autobusy Prazske integrovane dopravy). *“Tilting it to 45 degrees became very fashionable in the early 70s, but it was and still is a disservice to readers. If you cannot make all type horizontal (as well as upper and lower case), you’ve failed”*(Spiekerman in Bierut, 2004).

A common practice in several maps observed consist in setting route labels horizontally –such as service numbers- while positioning other features such as street names in different angles according to topography. However this is not always posible and many times service numbers should be display following to path’s orientation (i.e. Munich’s Verkehrslinienplan Stadt). This situation might create some reading conflicts and misinterpretations (i.e. In Paris Bus Map service *68* can be read as *89* when is oriented vertically). Nevertheless some studies have shown that some travelers tend to rotate their maps while searching direction or following a transport path. In this situation type orientation might support the tracking process.

The review of some cartographic convention on how to label point and linear feature will be further discussed later.

Type Color/Contrast

Color-coding has become a main feature in most Public Transport Maps and can simplify the identification of services. Sometimes typographic coding by color can reduce search time (Phillips (1978). Nevertheless, the selection of color can affect the contrast of type with the background and certainly determine the difference between a legible and illegible text. For this reason, the highest possible contrast between print and background is usually recommended in this kind of maps. (Cain, 2007; Denmark, 2000).

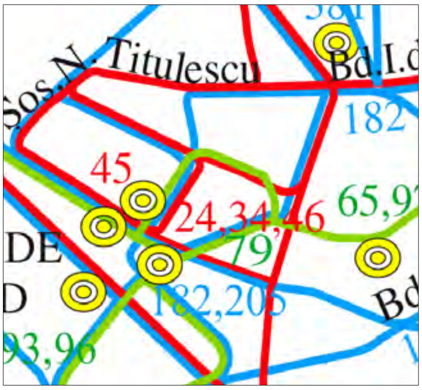
Train Nnetwork. Melbourne.

Often, the same color of routes’ lines is applied to service numbers (i.e. Melbourne ‘s Train Nnetwork). Legibility in these situations can be stressed in case of low contrast of text with the background (i.e yellow text with white background) or when colors are rather conflictive in text such as green and red (i.e. Bucharest’s Reteau de Transport in Comun).

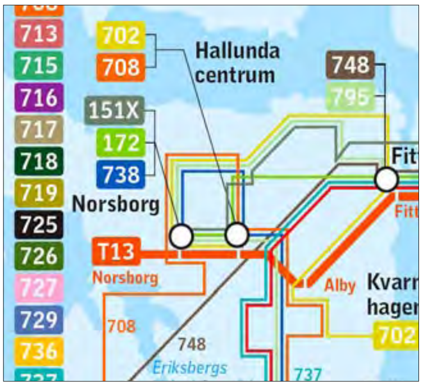
Along the small size of texts in maps, type contrast is usually mentioned as a main problem in public transportation printed material. (Cain, 2007). High contrast helps provide good resolution, which in turn assists in character recognition. Color combination such as black type on white is desirable but not always possible in maps.

Type set on color boxes is a common solution in this kind of maps to avoid conflicts between text legibility and backgrounds. This strategy is especially useful when both colors are too similar, when the combination of color vibrate or when the background show uneven colors (i.e. Stockolm's BusvHuBo).

Mapmakers should also acknowledge printing issues when using color type in maps, since printing reproduction technologies may cause small differences in the application of process-colors' inks (CMYK) on paper. This issue is especially critical when color type is set in small sizes. For this reason the use of a "flat' colors for text seems more reliable in these kind of graphics



Reteau de Transport in Comun. Bucharest.



BusvHuBo, Stockolm.

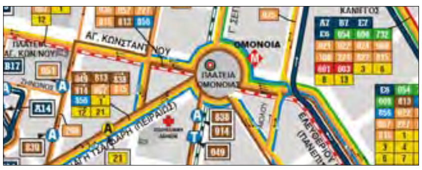
- **Labelling Public Transport Maps**

(See also Annex 1 with a complete inventory of Labelling Techniques in Public Transport Maps)

Route labeling is probably the most characteristic and perhaps the most complicated typographic feature in the design of Public Transport Maps. It can enhances or compromise its utility and appearance. The definition and consistent application of a labeling method for transport map should facilitate users recognition of services and improve the tracking process of its path.

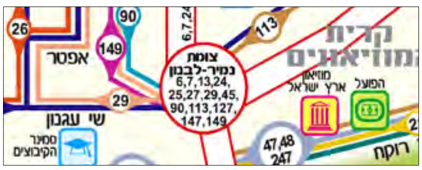
Urban bus of Barcelona.

The examination of Public transport maps does not show a unique solution for displaying route labels. From simple numbers alongside the lines to sophisticated graphic devices (i.e. Barcelona's Urban bus map), each map seem to establish a particular system. With the exception of some metro diagrams in the French style –that usually label only the terminals- most Transport maps represent their services with numbers along route-lines (i.e. OASA, Athens Urban Transport Organization).



OASA, Athens Urban Transport Organization.

Service numbers usually appear through different parts of a line, leading users to complete a route connecting the different segments of a path. In this process the correct placement, separation and orientation of service numbers and nodes names (i.e. stations) become a critical issue and can condition the map legibility. Another labeling technique exploits main route's intersections - stressing the connectivity of nodes- to display services numbers. This technique, mainly used in bus systems, is rarely applied in today's maps (i.e. Tel Avid bus map).

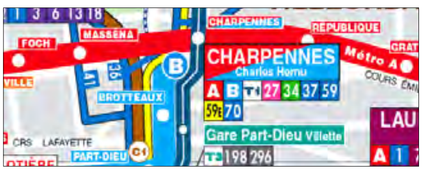


Tel Aviv Bus map.

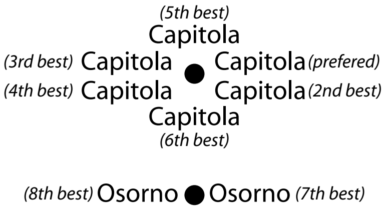
Point Symbol Labeling

Point Symbol Labeling refers to the process of positioning names of fixed locations in the map. A major task in this operation regards the positioning of text avoiding overprinting underlying graphics.

Point labels in Public Transport Maps -such as stations, interchanges, terminals and other features - should ideally not overlap route-lines, symbols or text. This is especially difficult in densely crowded areas such as cities' downtown (i.e. Lyon's Agglomération).



Agglomération, Lyon.



Sequence of preferred location for labeling point features based on Yoelis' schema.

In 1972 Pinhas Yoeli proposed a schema for positioning point labels in maps. The model has been later modified by other studies such as Imhof (1975). According to this schema when possible, labels should be placed on the right of symbols. Slocum et al. (2004) also notice that in this model the least preferred locations for a label seems to be directly to the right and left of the symbol. This can results in an "unfavorable optical coincidence" (Imhof, 1975), in which the point symbol might be misinterpreted as a type character in the label. However labeling conditions in many Public Transport Maps are far of being ideal and models such as the one proposed by Yoeli can only be use as a general reference.

If preferred labeling locations does not provide a suitable option, mapmaker often consider using a mask, halo, or callout or a simple leader line. These operations are further reviewed later.

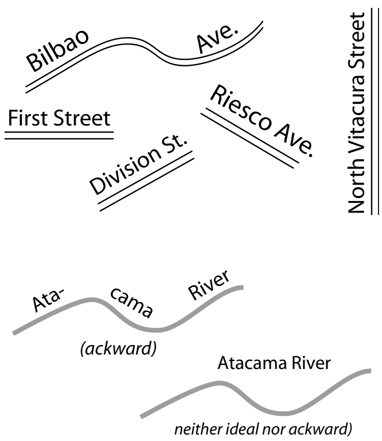
Linear Symbols Labeling

Linear features on thematic maps usually include rivers, streams, roads, railroads, streets, paths, airlines, and many linear quantitative symbols. The general rule is that their labels should be set solid (no letterspacing) and repeated as many times along the feature as necessary to facilitate its identification. (Dent, 1993).

Red de Líneas. Sevilla.

Since line symbols are one of the most important feature of Public Transport Maps, their clear identification is central for its performance. Route labeling in this kind of maps mainly identify services and street names. Service labels are often represented through numbers or a combination of text and symbols. In some maps these graphic devises can also communicate directionality through pointers, a very important features when the service route follows different paths in its way back.

A typical method for labeling transport services is to simply write the name directly above or below the line (road). This approach uses proximity to associate the label with its target road. Another procedure is to put the text on the line or near the road and then add a line pointing to the road to form the association between the label and its target. *(See also Annex 1)*



Some strategies for using orientation to associate labeles with line symbols

Street labels depend largely in the weight of the line. Name of a street can be place either within the line or next to it, but almost always they oriented according the street topographic orientation.

Very long linear features should be labeled more than once. For Morrison (1999), the use of multiple labels is usually preferred instead of exaggerating letter and word spacing, but implies several issues that will be further discuss in Chapter 8.

Labeling linear features that have complex curve or run vertically are also recurrent issues in these maps and require particular attention. For the first problem, Slocum et al. (2004) suggest to follow the general trend of the feature since type that curves too much is difficult to read. For the second problem, there is a cartographic convention that should be applied to all type that are not horizontally oriented in a map. In these cases the text should be readable from the right side of the page.

However one of the most characteristic problems in Public Transport Maps has to do with labeling services that overlap in the same road. This issue affect most maps independently its style. While in Classic style maps this situation is usually solve grouping all labels in a single agglomeration (i.e. Vancouver's TransLink map), in French style maps labels can be inserted within each line (i.e. Rhein-Ruhr's Linienplan Schnellverkehr).

TransLink. Vancouver.

Linienplan Sschnellverkehr. Rhein-Ruhr.

Chapter 7

Generalization: Main Graphic Operations In The Design Of Public Transport Maps

A good map tells a multitude of little white lies; it suppresses truth to help the user see what needs to be seen. Reality is three-dimensional, rich in detail, and far too factual to allow a complete yet uncluttered two-dimensional graphic scale model. Indeed, a map that did not generalize would be useless. But the value of a map depends on how well its generalized geometry and generalized content reflect a chosen aspect of reality (Monmonier 1996).

This chapter explains the concept of generalization, through different graphic operations regularly applied in Public Transport Maps.

As it has been explore in the first part of this thesis, the design of a map is a very complex task. A map author cannot just project the data onto a piece of paper, but also he has to worry about readability and comprehension of information. The way to improve the quality of the map is by using so-called white lies (Cabello 2004). Cabello exemplifies this in the case of a transport map: if the thickness of a road would be proportional to its width in real world, the user would not notice it on the map. Therefore, the mapmaker needs to make it thicker on the map than it would be otherwise according to the map scale. Furthermore, the design of a map is not only a complex task, but it also involves subjective decisions. For instance, the cartographer has to decide what information is not relevant and can be omitted from the map, how to improve its readability in cluttered areas, where to put labels with relevant features, what legend to use, and so on (Cabello 2004)

Cartographic Generalization is the process of selecting and simplifying the representation of detail of a source map appropriate to the scale and the purpose of a target map. This graphic operation corresponds to the fundamental human activity of abstracting and reducing complexity (Timpf,1998). Indeed, all maps are to some degree generalizations; as it is impossible to represent all features from the real world on a map, no matter what the scale (Slocum et al. 2004).

To better understand the complexity of generalization, cartographers and researchers have written on the topic for many years (i.e. Eckert, 1908, Wright, 1942, Raisz, 1962). Some authors have even attempted to design conceptual models of the generalization process focusing on fundamental graphic operations and the relationship among them (i.e. Robinson et al., Kilpelainen and McMaster and Shea). McMaster and Shea (1992) have proposed probably one of the most comprehensive models on generalization process' which can be synthesize in three key questions: *why* to generalize, *when* to generalize; *how* to generalize (Slocum et al. 2004).

- **Why Generalization Is Needed**

The theoretical or conceptual elements of generalization include reducing complexity, maintaining spatial accuracy, maintaining attribute accuracy, maintaining aesthetic quality, maintaining a logical hierarchy, and consistently applying the rules of generalization (McMaster and Shea). Reducing complexity is perhaps the most significant goal of generalization. The question for the mapmakers is relatively straightforward: how the map author reduces the information content so that it is appropriate for the scale. Obviously, the complexity of detail that is provided in a large-scale map cannot be represented in a small-scale map; some features must be eliminated and some detail must be modified. For centuries, through considerable experience, cartographers developed a sense of what constituted appropriate information content (Slocum).

The set of decisions required to generalize cartographic features based on their inherent complexity is still very difficult if not impossible to quantify, even several attempts have been made over the past decade, especially in the realm of automatic generated maps, where operations have to be accomplish by a particular computer algorithms (i.e. Grabler, Agrawala, Sumner and Pauly, 2008).

• When Generalization Is Required: Main Design Problems

The identification of the specific conditions where generalization is required is no an easy task. Among these conditions McMaster and Shea (1992) have identified:

Congestion
Refers to the problem when, under scale reduction, too many objects are compressed into too small a space, resulting in overcrowding due to high feature density. Significant congestion results in decreased, communication, for instance, where too many routes or landmark are in close proximity.

Coalescence
Refers to the condition where features graphically collide due to scale change. In these situations, features actually touch. This condition thus requires the implementation of the displacement operation, as discussed later.

Conflict
Results when, due to generalization, an inconsistency between or among features occurs. For instance; if generalization of take a apart a road and a landmark that is located on it, either the landmark or the road would have to be moved to ensure that the landmark remained relative close to the road. Such spatial conflicts are difficult to both detect and correct.

Complication
Is dependent on the specific conditions that exist in a defined space. An example is a line that changes in complexity from one part to the next, such as a coastline progressing from very smooth to very crenulated.

• How To Generalize: Fundamental Graphic Operations

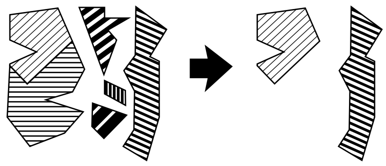
Generalization operations have been vaguely defined, so different authors may use diverse definitions for the same term or use different terms for the same definition (Rieger and Coulson, 1993). Although the growing use of information technologies to generalize maps has lead the isolation of many generalization operations, traditional cartographers and map designers have performed essentially the same operations "by hand" but with less structure, less formal awareness, and less consistency for years.

Most of the research in generalization assumes that the process can be broken down into a series of logical operations that can be classified according to the type of geometry of the feature (Point, Line and Area) or its content. For instance, a simplification operation is designed for linear features, whereas an amalgamation operation works on areal features.

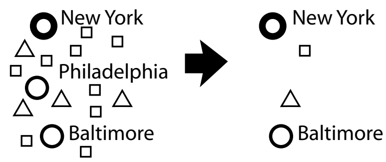
Among the generalization usually apply in designing Public Transport Maps are:

Selection:
Selection is a positive term that implies the suppression, or non-selection, of most features. Ideally the map author approaches selection with goals to be satisfied by a well-chosen subset of all possible features that might be mapped and by map symbols chosen to distinguish unlike features and provide a sense of graphic hierarchy. Features selected to support the specific theme for the map usually require more prominent symbols than background features, chosen to give a geographic frame of reference. Selecting background details that are effective in relating new information on the map to the viewer's geographic savvy and existing "mental map", often requires more insight and attention than selecting the map's main features. In the holistic process of planning a map, feature selection is the prime link between generalization and overall design (Monmonier 1996).

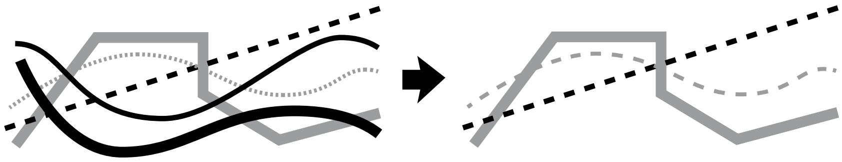
Area Selection



Point Selection



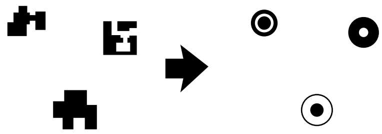
Line Selection



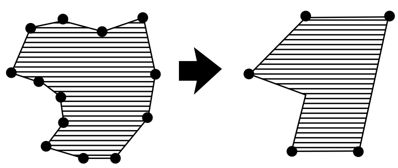
Simplification:
Simplification is the most commonly used generalization operation. The concept is relatively straightforward, because at its most basic level it involves a "weeding" of unnecessary coordinate data. The goal is to retain as much of the geometry of the feature as possible, while eliminating the maximum number of unnecessary characteristics (Slocum et al. 2004).

This operation reduces detail and angularity by eliminating points from the list, and is particularly useful if excessive detail was "captured", developing a cartographic data file, or if data developed for display at one scale is generated to be displayed at a smaller scale. (Monmonier 1996)

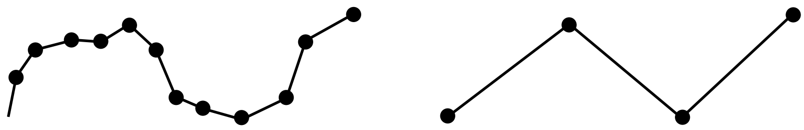
Point Simplification



Area Simplification



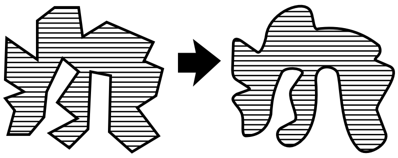
Line Simplification



Smoothing
Although often assumed to be identical to simplification, smoothing is a much different process. The smoothing operation shifts the position of points to improve the appearance of the feature. Smoothing attempts to plane away small perturbations and capture only the most significant trends of the line (McMaster and Shea 1992).

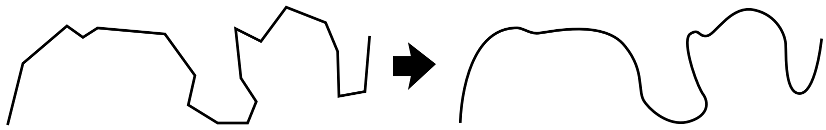
Research has shown that a careful integration of simplification and smoothing routines can produce a simplified, yet aesthetically acceptable, result (McMaster 1989A in Slocum, 2004).

Area Smoothing



Smoothing (Line), which also diminishes detail and angularity, might displace some points and add others to the list. A prime objective of smoothing is to avoid a series of abruptly joined straight line segments (Monmonier 1996). In Public Transport Maps smoothing is a very utilized operation, mainly use to round lines' corners giving a more continuous course of routes.

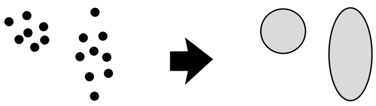
Line Smoothing



Aggregation

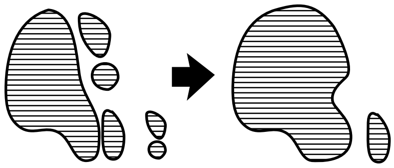
Aggregation involves the joining together of multiple point features, such as a cluster of buildings. This process involves grouping point locations and representing them as areal units. The critical problem in this operation is determining both the density of points needed to identify a cluster to be aggregated and the boundary around the cluster (Slocum et al. 2004).

Point Aggregation



Point Aggregation is useful where many equivalent features might overwhelm the map if accorded separate symbols. In assigning a single symbol to several point features, as when one dot represents an interchange station of twenty different shelters (i.e. interchange areas in Paris Bus map), aggregation usually requires the symbol either to portray the "center of mass" of the individual symbols it replaces or to reflect the largest of several discrete clusters (Monmonier 1996).

Area Amalgamation

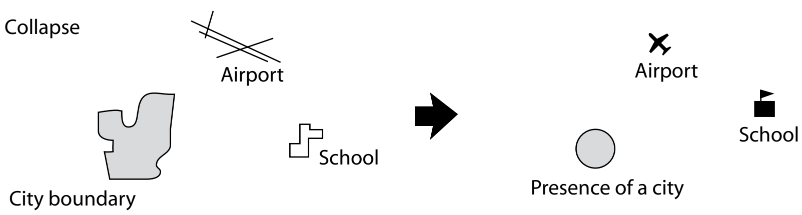


Amalgamation

Amalgamation is the process of fusing together nearby polygons, and is needed for both non–continuous and continuous areal data. A non–continuous example is a series of small islands in close proximity with size and detail that cannot be depicted at the smaller scale. Amalgamation is a very difficult problem in urban environments where a series of complex buildings or squares might need to be joined.

Collapse

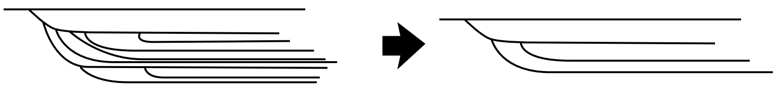
The collapse operation involves the conversion of geometry. For instance, it might be that a complex urban area is collapsed to a point due to scale change and reshaped with a geometric form, such as a circle or pictogram. A complex set of buildings may be replaced with a simple rectangle-which might also involve amalgamation.



Merging

Merging is the operation of fusing together groups of line features, such as parallel railway, metro or bus lines, or edges of a river or stream. This is a form of collapse, where an areal feature is converted to a line. A simple solution is to average the two or multiple sides of a feature, and use this average to calculate the new feature's position. Merging is a main graphic operation in Public Transport Maps, specially in the Classic Style.

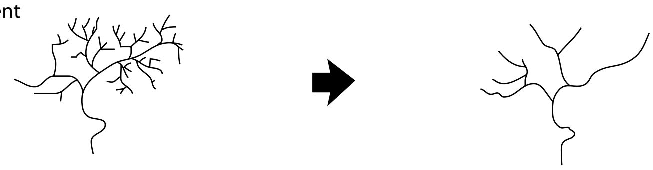
Merging



Refinement

Refinement is another form of, reshaping, much like collapse. However, refinement is an operation that involves reducing a multiple set of features such as roads, buildings, and other types of urban structures to a simplified representation. The concept with refinement is that such complex geometries are reshaped to a simpler form, a "typification" of the objects. In the case of Public Transport Maps refinement consist in selecting of a routes network to depict its "essence" of the distribution in a simplified form.

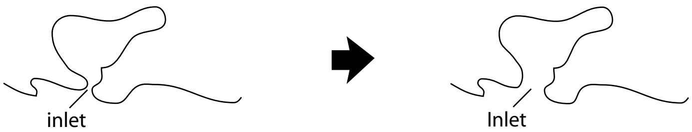
Refinement



Exaggeration

Exaggeration is one of the more commonly applied generalization operations. Often it is necessary to amplify a specific part of an object to maintain clarity in scale reduction.

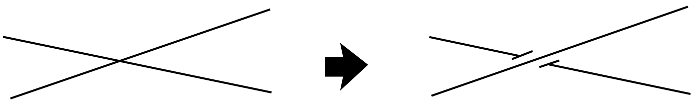
Exaggeration



Enhancement

Enhancement involves a symbolization change to emphasize the importance of a particular object. For instance, the delineation of a bridge under an existing road is often portrayed as a series of cased lines that assist in emphasizing that feature over another.

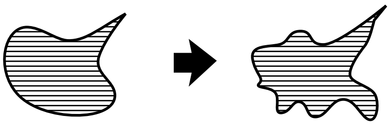
Enhancement



Roads cross

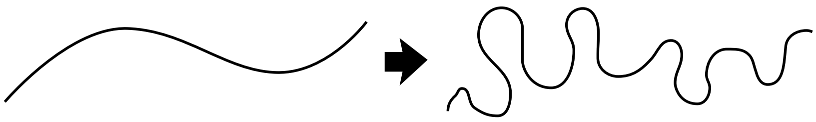
Road cross: one bridges the other

Area Enhancement

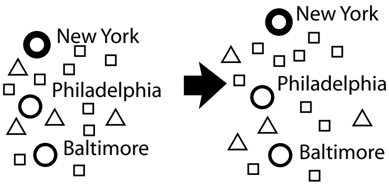


Enhancement in lines also adds detail to give map symbols a more realistic appearance. Lines representing streams, for instance, might be given typical: meander loops, whereas shorelines might be made to look I more coastlike. Enhanced map symbols are more readily interpreted as well as more aesthetic (Monmonier, 1996).

Line Enhancement



Point Displacement

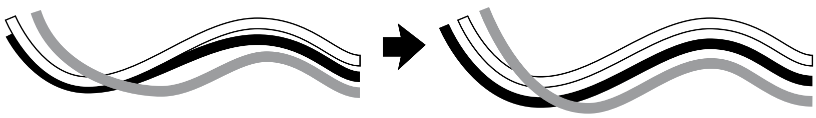


Displacement

Displacement is perhaps the most difficult of the generalization operations, as it requires complex measurement. In Public Transport Maps this operation is often use when two or more roads are in close proximity.

Displacement in line symbols avoids graphic interference by shifting apart features that otherwise would overlap or coalesce. A substantial reduction in scale (i.e.: 1:25,000 to 1:1,000,000) usually results in an incomprehensibly congested collection of map symbols that calls for eliminating some features and displacing others. (Monmonier, 1996)

Line Displacement

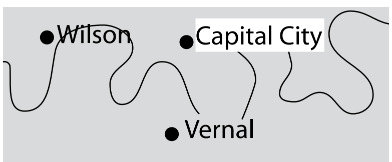


When displacement moves a label ambiguously far from the feature it names, graphic association with a tie line or a numeric code might be needed to link the label with its symbol (ibid).

• **Some Generalization in Map Lettering**

Overprinting

Overprinting is a phenomenon that occurs when a block of type is placed on too of another graphic object (e.g., a road), obscuring the type and making it difficult to read. To avoid overprinting is a main task for mapmakers. The effects of overprinting can be minimized through the use of either a *Mask*, *Halo*, or *Call Outs*.



Mask

- Mask

A mask is a polygon (e.g., a white rectangle) that is placed underneath type, but above the underlying graphics. Masks can sometimes obscure too much of the underlying graphics, and should be used with caution. Masks can also be specified with the same color as the background area, allowing them to blend in better. WilsonVernalCapital City

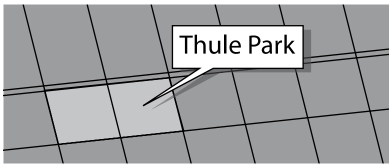
Halo

- Halo

A halo is an extended outline of letters in a type label [Figure]. Haloes cover less of the underlying graphics than masks, while still allowing the type to be read.

- Call Outs

Call outs are a combination of mask and leader line. Callouts are effective, but should be used with caution because they are visually dominant and can overshadow other map elements .



Call Outs

- **Content Generalization**

Beside *Geometric* or *Graphic Generalization*, Momonier (1996) propose another group of operations called *Content Generalization*. If *Geometric Generalization* seeks graphic clarity by avoiding overlapping symbols, *Content Generalization* promotes clarity of purpose or meaning by filtering out details irrelevant to the map's function or theme. *Content Generalization* has only two essential elements, selection and classification.(Monmonier,1996)

Content Selection

Content Selection, which serves geometric generalization by suppressing some information, promotes content generalization by choosing only relevant features.

Content Classification

Content Classification, in contrast, makes the map helpfully informative as well as usable by recognizing similarities among the features chosen so that a single type of symbol can represent a group of similar features. Although all map features are in some sense unique, usually each feature cannot have a unique symbol. Even though some maps approach uniqueness by naming individual streets or numbering lots, these maps also use very few types of line symbols, to emphasize similarities among roads and property boundaries as groups. It can be argue that the graphic vocabulary of each map is limited to a small set of *standardized*, contrasting symbols.

Chapter 8
Design Recommendation for Public Transport Maps

No one best way to a design solution can be predetermined for all maps – only principles and general approaches can guide mapmakers [...]. Good design is simply the best solution among many, given a set of constraints imposed by the problem. The best design will likely be a simple one that works well with the least amount of trouble. The optimum solution may not be achievable, and what is good design today may be ineffective in the future. We are constantly learning more about the map user, and this will modify our future decisions as designers (Dent, 1993).

The aim of designers and researchers is not to define the ideal map but to define the limiting conditions of functionality (Mijkseanaar. 1999)

So far it does not seems to be a standard neither recognized conventions for public transport maps. The samplers reviewed in the international survey show a wide variety of design approaches and graphic styles. Although similar design features and strategies can be found in different maps there is no a city with a transportation map equal to other.

Ambitious projects such as the one completed by the National Center for Transit Research (Cain, 2007) has attempted to address the lack of recognized design standards in American transit agencies arguing that such inconsistencies in graphic material contributed to an unnecessary source of user confusion.

The initial purpose of that study consisted in developing a printed transit information material design manual capable of assisting transit agencies in the production of effective and consistent printed transit information materials. However, as the project progressed, it became clear that the terms *"standard"* and *"design manual"* were too prescriptive, and that the term *"guidebook"* better reflected the type of document that was being developed.

As it has been discuss throughout this thesis the diversities in transport maps might reflect particular conditions –such as the city, its topography users characteristics, idiosyncrasy, etc.– all aspects difficult to standardized in printed maps. Nevertheless, the differences in the graphic quality of Public Transport Maps are evident and cannot solely be attributed to these conditions. Certainly the graphic ability and experience of mapmakers play a key role in the character and quality of a map.

Apparently some of the maps observed for this thesis were not executed according to basic cartographic or design notions. A considerable number of transport systems tend to subcontract external agencies for the design and production of their systems maps (i.e. more than 60% in the US according to Cain 2007). Designer Paul Mijksenaar point out that often, these projects are executed as part of large communicational contracts with advertisement agencies that are not necessarily aware of information design principles neither with mapmaking.

In this scenario the availability of guidelines (NO Standards) for designing Public Transport Maps appear to be a useful and necessary tool, no only for those who design the actual maps but also for transport agencies and those in charge of controlling its implementation. Most reports available by transport agencies reviewed for this thesis provide some sorts of design guides, but at the same time reveal considerable weakness regarding graphic aspect and its useful application.

This chapter introduces some *good practice* that might support the design of Public Transport Maps. These recommendations seek to synthesize, adapt and extend some existing design guidelines available through technical transport reports and other bibliographica sources. To fulfill this purpose it has include some design principles obtained from thematic cartography, graphic design and typographic literature. It also summarizes some observations based on the map survey done for this thesis and the author's professional practice.

• DESIGN PROCESS (base in Slocum et al. 2004)

The design process of a map can be resume into a set of general procedures. The list expands some concept of step 4 of the map communication model (Design and construct the map) reviewed in Chapter 1. This procedure is iterative, and need to be repeated until the map has been completed. Sometimes it needs to be done simultaneously, or out of the prescribed order.

• Determine how the map will be reproduced.
Reproduction considerations, such as the printing method might impact almost every aspect of the design process.

• Select the type of map (Schematic – Hybrid-Overlay) and the style (French – Classic) that better represent the transport system, users and it context.
If the map is design as an overlay (topographic) map a proper Scale and Projection should be decide. Look at previous maps done for the same system, as a reference.

• Determine the most appropriate methods of symbolization.

• Select which map elements to employ, and decide how each will be implemented.

• Establish a ranking of symbols and map elements according to their relative importance: "intellectual hierarchy."

• Create several sketch maps.

• Construct the map in your chosen software application.

• If possible, allow members of the intended audience to evaluate the map's effectiveness, and incorporate useful suggestions into your design.

• SELECTION OF THE GRAPHIC LANGUAGE

• Most of the time Public Transport Maps are a component of a larger information system, so codification and graphic language must be coordinated and consistent with the rest of the parts (i.e. stop signs, timetables, signage, bus information, website, etc.).

• In general the graphic language of the map should be in concordance with the institutional identity of the transport agency. This could give more credibility to the map - although in some cases brand identity definitions may interfere with map-making principles, undermining map effectiveness. (i.e. While an unmanaged brand colour strategy often leads to conflict between brand and wayfinding, a sensitive font definition may contribute to achieve both objectives).

•Be sure to count with reliable and up-today information about the transport system. Do not take important design decisions until having enough information regarding modes, services, interchanges, etc.

SELECTING THE TYPE OF MAP (Schematic Or Overlay)

Producing an easily understood transport map is not, a simple matter. Maps are complex in that they attempt to convey a great deal of diverse information. There are different forms of representing transport systems, the two extreme are a street map overlaid with the transport routes or schematic maps based on the route with indicators of stops and major destinations. Both types have advantages and disadvantages.

- Schematic Maps
Schematic maps are a simplified representation of the transit service area and the transit route alignments and can give a quick overview of the system and its main features. However, because they are not based on actual distances or even directions they hinder passengers relating to the real geography of the area. "Not To Scale" can mean that distances can be very distorted.

- Overlay Maps
Overlay maps generally use a street map of the service area on which the route is drawn. These can carry comprehensive information, especially about the transport routes in relation to streets, landmarks and other physical features; but they can also become overloaded with information and difficult to read.

- Hybrid Maps
A compromise solution between both extreme seems desirable for intermodal networks since it gives mapmakers more alternatives to arrange features in crowded areas without severe topographic distortion.

TYPE OF MAP ACCORDING KIND OF MODE (Base on Morrison, 1996)

According to Morrison (1996) Schematic maps are appropriate for representing some modes but not other.

- Underground Railways
Schematic maps seem to be the preferable solution in much systems, but more flexible approaches are also acceptable.

- Surface Railways
Schematic maps are acceptable, but may not be preferable. The traveler still perceives the railways as essentially straight, but is able to obtain some clues to his true location and direction of travel by looking out of the window (i.e. the sun, major riers, motorways, and may be disturbed if the schematic map shows things differently

- Trams and Light Rail
This mode is intermediate between buses and railways. Schematic maps are not desirable for those sections which follows streets as buses do, but may be more acceptable for off-street sections which resemble railways, and especially for underground sections.

- Buses
Overlay maps and intermediate hybrid solution between schematic and

topographic maps are acceptable. Schematic maps are definitely not suitable.

-Intermodal
Hybrid maps seem desirable. Schematic maps are definitely not suitable.

CONSTRUCTION OF OVERLAY MAPS

- Use an existing street map as a base-background

- If it does not alter drastically the notion of local space reorient the main axes of the city (i.e. main avenues) into an orthogonal structure Apply generalization

- Select the main nodes, paths, landmarks, edges, and districts of the city. (Lynch)

- Locate all the station and draw all the service line on the plan

- Identify critical nodes and paths where many routes converge or overlap

- Apply variable-scale enlarging the areas where critical nodes are located (without loosing topology)

- Apply one of Morrison Style for depicting service line (preferable the Classic style)

- Apply different generalization techniques reviewed in chapter 7 (i.e. simplify and straighten paths)

- Apply variable-scale distortion

CONSTRUCTION OF A SCHEMATIC MAP 45° (Based On Wolf, 2007)

- Keep the input embedding. This supports the mental (network) map of the passengers.

- Restrict all line segments to the four octilinear orientations horizontal, vertical, and both diagonals at 45ffl. Each orientation has two directions. This restriction makes maps clearer.

- Ensure that adjacent and non-adjacent stations keep a certain minimum distance. This increases the readability of the map.

- Keep the number of bends along a given subway line small, especially in interchange stations where several lines meet. If bends cannot be avoided, obtuse angles are preferred over acute angles, i.e., the order of preference is 135°, 90°, and 45°. This rule helps passengers to follow a subway line with their eyes.

- Preserve the relative position between subway stations. For example, a station being north of some other station in reality should not appear below that station on the map. This supports the (geographic) mental map of the passengers.

- Keep the total edge length of the network small. This indirectly makes sure that dense regions of the map get a larger share of the available space. Together with the third rule this also keeps distances between adjacent stations as uniform as possible. This should supports the clarity of the layout.

- Color each line with a unique color. It might help map users to follow a line with their eyes.

- Label stations with their names, and make sure that labels do not obscure other labels or parts of the network. Preferably all labels between two interchange stations are placed on the same side of the line; stations on a horizontal line may also be alternating labeled above and below the line to save space.

SELECTION OF STYLE *(Classic, French Or In Between)*

Morrison (1996) cataloged the diverse form of representing transport services in what he called "National Styles" (French, Scandinavian, Dutch and Classis). The most representative of these styles are the French and the Classic. Again, a wide variety of compromises between these two extreme styles are possible and desirable.

- French Style: One line for each service of a transport mode, each line in a different color; service numbers appear in general at the two route termini (i.e. London Underground diagram)

- Classic Style: One line for all services of each transport mode; individual services indicated alongside the lines (London Bus map)

Style according to Number of Mode (Base on Morrison, 1996)

The number of transport modes should be the first decision rule however the exact definition of a mode of transport is somewhat arbitrary. For example some systems treats trunk buses and local buses as two modes distinct from each other. In deciding the number of modes it would be permissible to ignore certain minor modes such as ferries, lift or funiculars. Sometimes two modes may be treated as one, e.g. trolleybuses and buses, because no distinction at all is made between them in the coloring or numbering systems used on the street.

One Mode (nearly always buses only):
Much overlap between routes (usual in urban areas)

Having a large number of bus services on one map is only a problem if they overlap a great deal, i.e. if there are many streets, which are followed by numerous bus services. Such overlap is usual in towns centre or on secondary centers.

Less than 10 bus services:
No problem, apart from the likely convergence of all the routes into one central street. Use "Fench style"" one color per bus service. (9 is the maximum number of colors which can be easily distinguished. See section color)

10-25 bus services:
Use "French style" but group the bus services into 9 groups which have the maximum length of route in common. Use one color per group. Ensure that the draw lines are adequately labeled along their length with th bus service numbers, in addition to labeling the termini.

Generally the groups will have to be determined by the mapmaker, but sometimes there are ready-made groups of bus services, which may be understood by travelers. For example using the same color for those routes running mainly in the same direction. The grouping of bus services can also be done according to the bus company or services (for example services 5, 15, 25, 35, 45, 55 are all variant of service 5 and can share the same color)

Over 25 bus services:
Again use "French style", grouping the bus services, but the result will probably not be satisfactory. The map of the whole network should nevertheless be

produced, but one should attempt also to produce maps of sub-sets of the bus services which preferably contain less than 10 bus services, and certainly not more than 25 bus services.

Little overlap between routes (usual in rural areas)
The network of bus routes serving villages in a rural area usually involves relatively little overlap, so that only a few links will be followed by more than two bus services. In this situation, there may be no limit to the number of bus services which can be clearly shown by about 9 colors using the "French style". The same color can be used to represent many different bus services provided they do not meet, and provided each is clearly labeled with its rout number.

Routes have many variants (usual in rural areas)
Another typical characteristic of rural bus routes is that they have many variants: different departures serve different sets of villages, although the carry the same service number. In some cases the various routes followed at different times by a particular bus service may form a small network. In this situation it is especially desirable to use the "French style" using a different color to distinguish each small network.

Two Modes
Use the "French Style' for one mode, preferably a mode which already has colors associated with services. Show the remaining mode by one color in Classic style.

Three Modes
If only one mode already has colors associated with services (i.e. Metro) , use the French Style for that one mode. Show the remaining two modes by one color each, in Classic style, preferably using associated colors. For example if the actual livery of a vehicle is already painted in a recognizable color.

If all 3 modes have an associated color, and no mode has color-coded services, use one color per mode Classic style.

In a case not covered by the above rules, either solution may be adopted.

Many Modes (4 or more)
Use one color per mode, each mode being represented in Classic style. Chose colors associated with the mode, if any. Beware of light colors associated with certain modes (i.e. yellow, light blue or light green) which will not show up on a white or light grey background. Consider casing the yellow lines, or using a darker blue or green, or changing the background color (i.e. medium grey).

Several Modes but one Predominates (usually buses)
A common situation is that there are several transport modes, but one mode (usually buses) predominates, so that using a single color in Classic style is not sufficient to distinguish all the different bus service to be shown o the map. In this case, some of the colors will have been used to represent the other modes, so the full nine colors will not be available to represent bus routes. It may then be appropriate to divide the bus services into less than nine groups, using existing groups, which have meaning to travelers. In effect these subdivisions are treated as if they were separate modes.

One of the commonest subdivisions is the distinction between town buses and country or "regional" buses. This distinction may or may not correspond to a difference of operator, administration, livery color or service numbering system. Another common way of subdividing bus services is by the operating company, each one with a different color.

In some countries (i.e. Germany) there has been a policy since 1990 of marketing express bus services as a separate "product", which therefore might be justifiably treated as a separate mode.

In deciding whether to subdivide the bus mode in this way one should consider whether is a clear association of colors.

Insets

If possible avoid insets. Otherwise put them on the same page as the main map and use the same style, route colours and codes.

GRAPHIC ELEMENTS AND SYMBOLS

Maps should show and label all major elements of the transport system including routes, major transfer points and interchanges. Topographic information and street names might help passengers orientate themselves. A legend and map instructions should also be included (TTI & NuStats 1998 p21).

SYMBOLS ON MAPS

- A Public Transport Maps should consider at least service lines and stops.
- The kind and number of symbols depend on the particular characteristic of each network.
- All symbols should be distinctive and recognizable.

Stations

Stop symbols are usually differentiated according to its hierarchy: Stops, Stations/Interchange/Intermodal and Terminals.This study has identified the several symbols for each one of these categories (See Anex 1). The most recurrent are:

- Stop
- Stations/Interchange/Intermodal
- Terminals

It should be clear graphic and hierarchical difference between these symbols. Ideally the form, size and application of symbol must be consistent throughout the map. These symbols should be labels next to them rather than on a map key.

- **Lines**
  - Differences in lines' weight should be in according to the a clear hierachie.
  - If two or more lines follow the same path they should be parallel.
  - Round bents, route alignment should be smoothed to avoid abrupt changes in direction.

• Route variations should be indicated using a dotted or broken line.

• Use arrows or similar symbols to support route direction. If a service follows a particular link in one direction only, then an arrow of some kind must be used to show the direction.

Background/ Area

• Background colour should not be used if it reduces the contrast of the text (ATCO, 2003).

• Grey shading and colored tints including background pictures, other than pale yellow, are best avoided.

• It is recommended that background colour be used to highlight or supplement specific items of information - and not be used as the sole means of conveying such information (ATCO, 2003).

Landmarks

• Provide a compass rose should be provideded, even directional concepts, such as "North", "South", "East" and "West" are not necessarily useful for many people.

• Showing significant landmarks, such as lakes and rivers, define an area better and help orientation.

• Provide all major landmarks served by routes and other major landmarks in vicinity.

• Divide landmarks into different categories (restaurants, public buildings, hotels, malls, etc), identify each category with a different icon (different shape / different color), and provide a legend.

• If possible provide intersecting street addresses for all identified landmarks.

• Superimpose a grid (rericule) over the system map and provide co-ordinates for each landmark in a table at the side of the map.

• If posible provide street names for all major streets served by the routes, plus other major streets.

• Use standardized icons to represent different types of landmarks. Symbols should be accompanied by corresponding labels.

COLOR/CONTRAST

• Use the highest possible contrast between print and background.

• Ideally the background should be on a lighter color.

• Color-coding should be used to identify different routes on the system map.

• A maximum of nine colors is recommended for route lines, though it is posible to use as many as 13 different colors.

• Colors should be different, distinguishable and easy to name. Recommended nine colors are red, green, yellow, blue, orange, brown, purple, light blue, black

• Use of "special" or "decorative" color should be minimized.

• Certain color combinations are not appropriate (i.e. avoid using red or green print -Denmark, 2000).

• Adjacent routes lines should feature contrasting colors.

• Terminals and Stations should be in Neutral Color (i.e Black or White)

• Bus stops should be the same color as the route.

• Streets and highways should be in different color than route lines

• Streets and highways should be in medium to light grey or eventually white if the background is in color

• Streets and highways should not have outline

Partial color-coding may be used where the number of routes is greater than nine. By this method, each of the nine colors is used for multiple routes. If this method is used, the following points should also be considered:

• Number of colors used should be kept below nine.

• Keep the number of routes per color approximately equal.

• Arrange the color coding so that the adjacent routes feature different colors.

• Only if necessarily patterned route lines

• Indicate landmarks in their natural color i.e. blue for water and green for parks.

• Typographic coding by color can reduce search time; irrelevant coding can increase it. (Phillips,1978)

TYPOGRAPHY & LABELLING

Text reading is not similar to map reading, at least in terms of type. (Bartz, 1970).Critically evaluate and apply type specifications such as type family, type style, type size, letter spacing, word spacing, kerning, leading and type orientation. Do not passively accept the default settings provided by software application (Slocum et al. 2004).

Selecting a Typeface

• Legibility of type must be considered in relation to the legibility of the map as a whole (Phillips, 1977)

• Fonts should be chosen for clarity and simplicity independently if they are serif or sans- serif. However most of the maps reviewed for this thesis opted for sans serif typeface.

• A proper typeface for a map must meet the following features:

• The typeface must be legible in small sizes.

• At the same time, the typeface must also be slightly narrow, to avoid line lengths running too long.

• The different styles and weights of the typeface must be clearly differentiated from one another.

-Individual letters must also all appear different from one another, to help minimize misreading and misunderstandings.

• The typeface must be able to form good word shapes, which will also directly increase legibility

• For the sake of consistency, map elements such as the title, subtitle, legend heading, legend definitions, data source, and scale should all employ the same typeface. If two type families are required (e.g., to label a wide variety of map features), choose families that are distinctly different-one serifed and one sans serif, for example.

• Avoird complicated or decorative fonts (Denmark, 2000).

Type Size

• Typographic coding by point sizes can reduce search time; irrelevant coding can increase it. (Phillips,1978)

• Choose a realistic lower limit for type size; all type needs to be readable by the intended audience.

• Generally speaking, type size should correspond with the size or importance of map features. This does not suggest that label sizes are proportional to the sizes of features (It should be an ordinal association).

• Rarely should there be more than four to six different sizes in the whole map (Dent, 1993). Avoid differences of less than two points if possible. Users are not sensitive to slight differences in type size (Shortridge 1979).

• Use type size consistently (eg all street names in the same size) (Bloch & Hoyt 1992 p17).

• Consider factor such as the age and visual acuity of the map user, map reproduction method, anticipated lighting conditions, and the map user's physical proximity to the map.

• Recommended sizes for the smaller type in a maps vary according to users' studies and are mainly base in a minimum point size. It should be acknowledge that point size is a relative measure, since it vary depending on the type design. A realistic "conservative" size thought, can be 7 points (Monmonier, 1993). As a reference the minimum size of most American transport maps is 6 pts. (Cain 2007)

Type Variant

• Bold type is no more legible than normal weight type and should be avoided as it has a cluttering effect on maps (Phillips, 1977).

• Cursive italics and outlined and shadowed type styles are also very difficult to read and should not be used (Parks Canada 1984 p9; Geehan 1996 p37; Association for the Blind).

Type case

• Good lettering design on the map can be achieved by contrast of capitals and lowercase (Dent, 1993).

• Names set in lowercase with an initial capital are easier to find than names set in all capitals of the same point size. Lowercase names are recommended. (Phillips et alt., 1978)

• Use all capital letters for labeling large and important features

• Names very difficult to pronounce [e.g. LLANUWCHLLYN or SZLICHTYNGOWA) should also be set in capital letters. (Phillips, 1977).
Where emphasis is required, bold type may be used (ATCO, 2003).

Type Spacing

• Legibility also depends upon text spacing.

• The boldness of lettering and the distance between the letters should be chosen so that the shapes and intermediate spaces are clearly recognizable.

• Large print readers may make use of the patterns of space around each character rather than the letters themselves.

• Lettering that is too bold should be avoided as with lettering that is too thin (GFMH 1996).

• Increasing the leading between the lines can improve clarity. Leading of at least 120% should be used (eg 14 point type with 16.8 point leading) (ATCO, 2003).

LABELLING & PLACEMENT

• All type should be spell-checked. Special attention should be focused on the most current spelling of place names, which change over time and are often controversial. Also, be aware that certain older place names are considered to be offensive or derogatory today's standards (Slocum et al. 2004).

• Similarly roman numerals should not be used, as many people do not understand what they mean (Bloch & Hoyt 1992 p17).

• Labelling next to symbols, rather than on a key, helps those who have information processing problems (Hunter-Zaworski & Hron 1993 p26).

• Keep labeling consistent throughout the map.

• Point Symbol Labeling

• If possible names and route label should never be placed so they overlap route lines.

• Type should be placed in as clear a space as possible. Avoid clutter close to the initial letter of a word. (Phillips, 1978)

• Ideally orient all type horizontally.

• An exception is when labeling diagonal or curved linear and areal features, in which case the type should reflect the orientation of the features - very common in transport maps (Slocum et al. 2004).

• Choose a plan for the lettering placement of the whole map in accordance with the normal left to-right reading pattern.

• Avoid placing labels and names vertically.

• Never position names so that parts of them are upside down.

• Ensure that all type labels are placed so that they are clearly associated with the features they represent. In pursuit of this goal, it is often useful to place larger type labels first, followed by intermediate and then smaller labels (Imhof 1975).

• When labeling point features, select positions that avoid the overprinting of underlying graphics according to the sequence of preferred locations illustrated in chapter 6 of this thesis.

• Do not allow other map features to come between a point symbol and its label

• Emphasize the association between the label and symbol by placing the label close to the symbol, even if it means choosing a less preferred location (Slocum et al. 2004).

• If the sequence of preferred locations does not pro vide a suitable option, consider using a mask, halo, callout or simple leader line

• Large transfer centers should feature a labeled box containing all route numbers that serve the center.

• Some transport system have special editions of their maps where numbers replace the name of the station. These maps can simplify the navigation of the system, specially when the user is confronted with a different writing system (i.e. Tokyo's Metro)

• Line Symbol Labeling

The general principles for designating Linear features on Public Transport Maps is that their labels should be set solid (no letterspacing) and repeated as many times along the feature as necessary to facilitate its identification.

Route numbering

• Identify each route by a unique color and label (number or letter)

• Identify all individual routes and services and allocate to each one a unique route or service number.

• Route numbers are essential for use as shorthand on busy system maps and are the primary method of identification on vehicles.

• In allocating route or service numbers, group them in some logical way based on area of operation or depot of origin.

• Route numbers should be indicated at the beginning and end of any major deviation or separation of the route. You may need to include a key with both route numbers and route names on it.

Route names

• Do not use route names based on streets or landmarks.

• Route names based on streets or landmarks can cause confusion when used on maps, especially among inexperienced users or those who cannot easily read the local language (Higgins 1993).

• Route numbers should be grouped in a logical manner based on area of operation or depot of origin. Route numbers should be indicated at the beginning and end of any major deviation or separation of the route.

• Route names based on streets or landmarks can cause confusion when used on maps, especially among inexperienced

• The ideal location of the label for a linear feature is above it, along a horizontal stretch if possible.

•Do not crowd the label into the feature. Room must be reserved for lowercase descenders, if any.

• Use route numbers before and after where routes join or separate.

• Every link should be labeled

• If possible every link must be labeled with the numbers of the bus services, which follows that link.

• Label all bus services

• On a particular link, if the numbers of any bus services are written, then the numbers of all bus services must be written (i.e. the absence of a bus service number carries negative information: the bus service does not follow that link).

• Type should be placed uprigth and should read from left to right. Vertical Type should be readable from the right side of a page.

Aereal Symbol Labeling

• Avoid curve letters an number base line. If not possible curve should be gentle, smooth and constant for the entire word.

• Do not hyphenate names and labels, unless a hyphen is use as a service separator (no recommended)

• If a line of lettering is not horizontal, make certain it deviates significantly from the horizontal so that its placement will not look like a mistake.

• Do not locate names and labels in a way that the beginning and ending letters are too close to the feature's borders.

• Areal features that are too small to contain a label should be labeled as if they were point symbols (Slocum et al. 2004).

• If necessary, leader lines can be used with areal features. Leader lines should be very thin (e.g., 0.25 point), not include an arrowhead,

• The use of abbreviations should be conditioned to users familiarity.

LEGENDS & INSTRUCTIONS

Legend can help with interpreting the map including providing information on color coding, indicating whether all the timing points or bus stops appear and whether the map is to scale.

• Legends and keys should be placed on the same side of the page as the map.

• Map keys must be clear, simple and not overloaded with irrelevant information.

• Information on the map keys, including any symbols and color codes, should match exactly what is displayed on the map for easy cross reference (Bloch & Hoyt 1992 p11).

• Maps should include information on service hours of operation and fares

Instruction and institutional Information

• Include instructions on how to use the map and, if possible, basic "how to ride" information.

• Take advantage of any empty space at the bottom of a page to convey related information such as other services with which the route connects, special ticket details or operation under contract to a funding authority - but avoid too much clutter. Non-essential information should not distract the reader. A certain amount of white space helps the eye to find things (ATCO, 2003).

• Include telephone information number, website, e-mail and addresses of information centers.

• If possible Include basic fares information where possible, such as sample fares between main centres and validity of return tickets, network-wide tickets, etc.

• Include the publishing date

• Include the transport agency logotype (where possible)

ADVERTISING

Some transport authorities and operators may wish to recover some of the costs of producing maps by including advertising on them. This should be done with great care. Maps already contain a great deal of complex information – the addition of other irrelevant commercial information may just serve to make the maps more difficult to use and may negate any benefit to be had from any income received. If advertising is displayed, it should be visually separated from the map itself – for example on the reverse of the page.

PAPER FORMAT & PRODUCTION

• The fewer the folds, and the smaller the size, the better the map (Bloch & Hoyt 1992 p9).

• Strike a balance between size and legibility. (Denmark, 2000)

• Map size should allow ease in handling.

• Recent American report has suggested a maximum size of 770mm x 770mm (TTI & NuStats 1998 p21).

• It is recommended that good quality white paper be used to minimize "shadow" from the opposite side, rather than thin, flimsy or highly reflective paper, which impairs contrast and readability (ATCO, 2003).

• Printing ink should be selected to optimize contrast (ATCO, 2003).

• To enhance visibility under all conditions, sign characters and backgrounds must be flat, matte, or "eggshell" in finish. No glossy paint or finish should be used. Gloss produces glare points under certain types of lighting and lighting angles that will limit legibility drastically.

DESIGN TIPS

•Create a document that will certainly be modified in time (eventually for other mapmakers)

•Organize the information in layers (i.e. each service in one layer). It will simplify the design process and the future edition and upgrades of the map.

•Name each layer according to the feature contained in it (i.e. "Nffl107" if it is the layer containing service 107, or "Topographic Landmarks" if the layer contain a river or other natural references). This may facilitated other persons to manipulate the document

• Make and print as much proof as possible.

Chapter 9
A Problematic Case

Santiago's new Public Transport Maps (Transantiago)

"Here is one of the few effective keys to the design problem – the ability of the designer to recognize as many of the constraints as possible" (Charles Eames, 1974).

This chapter reviews the navigation system developed for Santiago de Chile's new public transportation plan "Transantiago" which considers a radical change in the way million of users navigate the city. It introduce some of the particular variables that affected the way the project was conceived, designed and implemented, presenting two of its main components: the Transantiago's Typeface System and its Network Map.

As it has largely discus through this thesis local variables directly or indirectly determine the design of navigation systems for public transportation. Although many cities share similar wayfinding strategies to guide passengers to their destination, their designs and graphic solutions still respond to multiple conditions.

Such is the case of the navigation system recently developed for Santiago de Chile's new transportation plan: Transantiago. This plan had to respond to radical changes in a single day, introducing a whole new operating system and therefore a whole new relationship between transport users and their city. Its integration of multiple variables – many of them unexpected and not readily handled with conventional methods – became a major design challenge.

The following case study presents some of the difficulties faced by the design team commissioned to develop its navigation system and its System Map.

• Santiago's public transportation context

Santiago the capital of Chile (population of over 6 million/ 1,400 km2), is a spread out and quite fragmented city. Every day, many of its citizens cross the city to work, spending more than an hour traveling each way. According to the "Origin-Destination" survey (EOD, 2001) the city's old bus system, usually called "Micros,", covered a wide geographic area (it was possible to cross the entire city without changing buses, and only 18% of journeys required a bus change), was widely accessible (98% of inhabitants live less than 8 blocks from a bus stop) and offered frequent service (mean waiting fare was low, costing the equivalent of USD 65 cents. However, waiting times were in fact unpredictable. The competition for passengers led to aggressive bus drivers and a high accident rate. The system was noisy and polluted, and the lack of cleaning and preventive maintenance was evident (Minteguiaga, 2006). The Micro system developed its own way of providing transport – its own culture – shaping through the years not only the way Santiago's citizens travelled around the city but also conditioning users' behavior. This ranged from Micros' drivers, most of them owner of the bus feeling that they had the right to impose their own rules, to passengers who stopped the bus anywhere, or to construction workers, who made up for lost sleeping time by taking advantage of the long rides.

Two images of Santiago's old bus system, usually

Transantiago

Transantiago Transport Plan, probably one of the most ambitious transport reform ever attempted by a developing country (Hidalgo cited in The Economist, 2007).

The new public transport system, Transantiago, was projected to replace, in a single day, the chaotic Micros. The new system was considered the most ambitious transport reform ever attempted by a developing country (Hidalgo cited in The Economist, 2007).

Transantiago works by combining local bus lines (Feeders), main bus lines (Trunks) and the subway (Metro) network. It includes an integrated fare system that allows passengers to make bus-to-bus or bus-tometro transfers for the price of a single ride, using prepaid smartcards.

Among Transantiago's original objectives were encouraging the use of public transport, enhancing the quality of public transport, eliminating the on-thestreet competition and replacing the existing bus fleet, palliating the city's high air pollution and sound pollution levels by reducing the number of buses, and being socially, environmentally and financially sustainable.

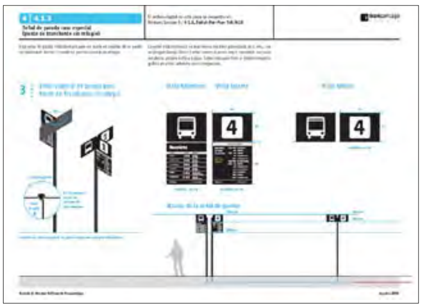
Following successful experiences in other Latin- American cities (for example, Transmilenio in Bogotá), the Ministry of Transport (MTT) decided to externalize the operation of the whole network to the private sector: buses, ticket sales, income management, etc. The operators were given responsibility not only for the coordination of services and fares, but also for the management and delivering of user information. (Gschwender, 2006)

Transantiago Graphic Navigation System / The Project

In 2003, a team constituted by UK-based transport consultancy Steer Davies Gleave and Pontificia Universidad Católica de Chile's Department of Typographic Studies was commissioned by MTT to develop Tansantiago's Users' Navigation System

In 2003, a team constituted by UK-based transport consultancy Steer Davies Gleave and Pontificia Universidad Católica de Chile's Department of Typographic Studies was commissioned by MTT (public tender) to develop Tansantiago's Users' Navigation System and define its graphic guidelines. The team was mainly composed of graphic designers and transport engineers, but also included sociologists, historians, geographers, psychologists and urban planners.

The project consisted of two phases. The first phase (6–9 months) contemplated the comprehension of the new network, a systematic research on user's context, user's needs and a diagnosis. It also considered definitions such as a coding system and preliminary designs. After a year, the second phase (5-12 months) considered testing and pilots, and refining and delivering the design guidelines.



One page of Transantiago's Tansantiago's Users' Navigation System guidebook

A design guidebook was defined as the official assignment output. Thus, one of the main purposes of the project was to deliver a clear and simple operative tool that could reduce misinterpretation throughout the entire editing, design and production process. For this reason, the guidebook includes full-scale digital templates of all the information elements present in the system, design recommendations and production instructions. It also includes the design of a custom typeface system and a comprehensive network map. The design of Transantiago's guidebook became a complete assignment by itself; the finished guidebook was completely downloadable through Transantiago website.2

Particular Variables

Defining, managing and coordinating multiple variables and constraints became a main challenge of Transantiago Navigation system, and certainly the most demanding one. Reviewing some of these variables could serve to illustrate the complex scenarios involved while addressing its design.

The "Big-Bang"

According to planners, the introduction of the new network was incompatible with the old one, so no transition between the two systems was considered possible. The so called "Big-Bang" strategy implied a complete system setup overnight. On February 10, 2007 at 00:00 hrs, a brand new transportation network (with new buses, new routes, new bus stops, new transfer stations, a new payment system and a new user information system) had to be fully operative and running throughout Santiago's streets. Hence, from one day to the next, citizens were forced to become tourists in their own city. This extreme operation entailed large sacrifices, costs, stresses and major cultural changes for users. In this situation, the navigation system had to play key roles, not only helping people find their way through the city, but also mitigating users' "information anxiety."

Users Not Used to be Informed

In the old system, with the exception of the Metro (for years a Chilean pride), there was no way to plan a trip ahead or to obtain information about services. The few initiatives to organize information that had been commissioned by MTT had been unsuccessful. The only way users could obtain a bit of information was on the buses from boards displayed in their windows or by directly asking the bus driver. The situation became even worse in 1991, when all of Santiago's buses were coded with an arbitrary route number and their livery became uniform (yellow & white) in a governmental effort to visually unify the system, making it even more difficult for users to recognize their bus line. Although daily exposure to this precarious situation allowed frequent users to distinguish their bus among the so-called yellow plague, the situation was quite stressful for elderly people and foreigners.

Informal hand lettering boards displayed in their windows were the only way users could obtain a bit of information on the old "Micro" system

Although the new system's original design brief did not contemplate either an educational campaign ("staged strategy), or the system's implementation, assigned to a private operator under the name of "Transantiago Informa," the design of the navigation system could not ignore the fact that Santiago's public transportation users were not used to consistent transit information.

Santiago's Image

Like most Public Transport projects Transantiago has espected to have a great impact in modeling the image of cites (Lynch 1960). Conversely, the development of the graphic support system could be used as a platform to discuss how citizens perceive, conceive and use their urban space. It could also become an opportunity to think about Santiago's rapid transformations and its changing identity.

In recent decades, Santiago has experimented a drastic renovation of its infrastructure and services, becoming one of Latin America's most developed cities. Like many urban centers, Santiago is competing to attract investment and tourism, a phenomenon that usually goes along with the need to create a strong and recognizable identity. Transantiago was thus seen not only as a project that could improve the city's weakest service but as a chance to promote Santiago.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Customized cabins, hand-lettered signs, popular performers aboard and other eccentricities characterized a ride in the old yellow buses.

Official vs. Popular Language

One of the most recognizable features of Santiago's urban identity was its informal and vernacular bus system. Customized cabins, hand-lettered signs, popular performers aboard and other eccentricities transformed a ride in the yellow buses into a unique experience. It can be argued that these manifestations in part reproduced the negative and chaotic condition of the system, but they also reflected a distinctive formal language with recognizable codes and cultural values.

Pursuing a new quality standard, authorities not only wanted to introduce a new transport system but also a new technical lexicon. Its terms, such as multimodal, integrated, transfers, interchange station, trunks, feeders, smartcard (branded "bip!") among others, were completely unfamiliar and meaningless for most citizens. These top-down concepts, however, had to be quickly learned, accepted and integrated by transport users into their vocabulary and daily routine. The definition of a suitable language and a proper interface for Transantiago became therefore a difficult task – especially considering that the old bus system had a particular visual and verbal vocabulary, strongly attached to popular culture and user idiosyncrasy.

President Lagos takig a Transantiago Bus during a promotional campaing. Transantiago became an emblematic project for the Chilean Government, a national priority that had to respond to citizens' expectations and elections deadlines.

Political Connotation

For decades, bus transportation in Santiago was considered the bottom of public services. Atomization and selfregulation were considered an endemic problem of the old Micros network. In 2000, the transport system was operated by over 3,000 microbusinesses with an average of two buses each (Minteguiaga, 2006). This was in part the cause of irregular services, arbitrary administration of information and users' frustrations and criticisms. Although most surveys showed the citizens of Santiago were overwhelmingly in favor of a new transport system, local authorities were unable to solve this "gridlock." Such a change in a city that concentrates almost half of all Chilean voters was a challenge, but also a risk fully loaded with social and political implications. Transantiago become an emblematic project for the Chilean Government, a national priority that had to respond to citizens' expectations and elections deadlines.

Stakeholders

Although the MTT was the original commissioner of the project, constant changes in its structure as well as in politics produced an unstable platform with which relate. During the project's execution, there were two Presidents, three Ministers of Transport and three Transantiago Directors. Each newcomer wanted to put a personal fingerprint in the project, demanding changes and designs already defined by a predecessor.

Graphic integration

Transantiago's decentralized structure and the eventual frictions and disorganization among their operators could not be allowed to jeopardize users' perception of an integrated network – one of the most promoted features. Therefore, guaranteeing the visual consistency of Transantiago became a major concern. Although the MTT had a coordinating role during the design and setup of the project, the whole system was planned to be run independently by different private companies. This operating structure leaves a lot of room for misinterpretations and disputes among operators, not only regarding the responsibility of producing, implementing and supervising the navigation system, but also managing and upgrading its information. Consequently, defining clear and applicable guidelines, reducing production costs and facilitating content editing turned out to be main goals for the navigation system.

Unreliable Data

The selection and translation of rough data into comprehensible information is a permanent commission in this kind of project, so the interaction between transport engineers, designers and geographers as well as the fluid communication among stakeholders was crucial.

The Navigation system had to be designed while Transantiago's operative plan was still under development. Even as the authority defined a referential framework, most of its components had to be projected with simulated data. The lack of reliable information conditioned the definition and design of the system, its codification, most of its components, its evaluation and its production.

Accessibility

A complete, parallel project was assigned by the MTT to a group of experts to study Transantiago users' accessibility needs. Periodic discussions were held with special interest groups regarding these issues. Most recommendations were considered in the design of the navigation system.

• Transantiagos' Typeface System (TS)

Although it was not considered as part of the original assignment, there were several issues that justified the design of a custom typeface for Transantiago.

Legal & Copyright issues

Designers, printers and producers of graphic products in Chile are not accustomed to purchasing original fonts. The lack of regulation and typographic culture often cause the replacement of specified fonts with default "system" ones (i.e. Arial or Times NewRoman) or the use of different versions. A scenario like this could jeopardize the consistency of Transantiagos' navigation system, especially considering that its administrative structure gives each operator responsibility for the editing and production of signage and informative material. Having a free (open-license) typeface for Transantiago, easy to download from the system's official website not only could reduce purchasing costs but safeguard authorities and operators from legal and copyright problems.

Although it was not considered as part of the original assignment, there were several issues that lead to the design of a custom typeface for Transantiago.

Legibility

As it has been demonstrated by several studies reviewed before, legibility is a critical issue in public transport navigation systems, especially since many of the information provided to users is text-based and has to be delivered through different formats, sizes and environmental conditions. Variables such as distance, placement or movement, among others, affect perception of messages in a bus, in stations or even while reading a map in normal conditions.

Therefore the development of a typographic system needs to consider particular formal features: good contrast, large, open counters, ample lowercase x-heights and distinctive character shapes could determine the correct or incorrect recognition of a bus number, the correct comprehension of landmarks and street in the map.

Local references

As was mentioned previously, the old Micros had a recognizable visual language that had become an important part of local identity. Although Transantiago's communication campaign was pursuing a complete renewal of Santiago's public transportation image and public perception as a "modern" system, authorities could not ignore the cultural value of such a popular convention.

Some characteristics of the popular letterforms were considered in the design of Transantiago's typeface

Concerning the future of this vernacular tradition, the design of the navigation system originally considered some spaces in the bus to be customized by local "letterists". Although authorities dismissed this proposal, they did accept the idea of introducing some characteristics of the popular letterforms in the design of Transantiago's typeface. Hand lettering, brush strokes and other particular features, such as abbreviations and separators, became the reference for the new, legible and completely functional font. This typographic project though did not claim to imitate the original models, but honored a traditional craftsmanship that was about to disappear. It was also meant to bridge symbolically the uniqueness and spontaneity of the Micro's network with the regularity and rationality expected in the new system.

Most textual information in Transantiago's navigation system is displayed in signs and maps. Transantiago's typographic system uses two fonts: TS Info, designed for large sizes and TS Mapa, designed for small texts. Both fonts include different typefaces and different weights. They also include a set of special characters (such as special abbreviations and ligatures), symbols (pictograms and arrows), glyphs (boxes) and corporative figures (logotypes) that could be easily accessed through the keyboard according to the task.

A new "Stop" sign using TS font.

The direct feedback between type designers and the real applications allowed simultaneous revisions and upgrades, facilitating design and reducing the time needed to edit and produce information pieces. In fact, Transantiago's font became more an operative tool than a set of letterforms.

Language & abbreviations

Spanish is the predominant language used in Santiago. However, many landmarks and streets have been named in Mapudungun (Mapuche language) or in other foreign and native languages. A considerable number of these names include very uncommon combinations of characters and accents not often used in Spanish. Most professional fonts already include a full set of accents and international glyphs, and Transantiago's font also made optical adjustments of particular characters and facilitated their keyboard access. The Transatiago (TS) typeface system also introduced a full set of traditional abbreviations and signs (such as "Hosp" for Hospital, "Muni" for Municipalidad (Town Hall), etc.). Defined after studying the existing "Micro" signs, these abbreviations not only recognized current language practices but saved considerable space on signs.

• **Transantiagos's maps**

Transantiago's navigation plan was designed to have a set of different maps and diagrams meant to work as a system (complementing each other), delivering specific information during the different stages of travel, according to user needs. The set of maps included: single route diagrams, thermometer diagrams (inside buses), "You are here maps" (for interchange stations and shelters) and a Network Map, the most complex piece of Transantiago's navigation system.

Transantiago Network Map

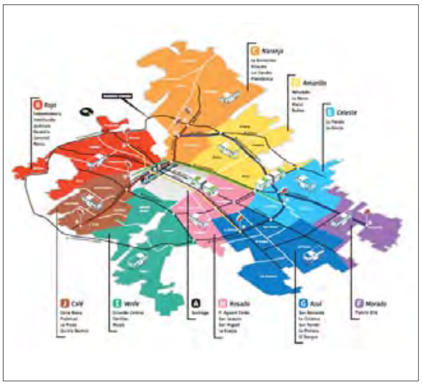
The Network Map represents the entire network in a pocketsize booklet and contains tables with complete route list and basic instructions on how to read the map and interact with the system. Since it was the only piece of the whole navigation system that was fully implemented (two million copies were printed in its first edition) it has become the main source of information for Transantiago's users.

Transantiago's first edition of the Network Map. December 2006

If designing a transport map such as Transantiago's is a very complex task, reading and understanding it can be even tougher, especially when readers have not been exposed to this kind of instrument before. According to Mijksenaar (1999), map reading requires a certain level of knowledge and training. The design of Transantiago's Map had to deal with the representation of a complicated system and its users' limited knowledge of such systems. In fact, users not only would have to learn a brand new transportation plan from scratch, but also would have to be trained to read and interpret maps.

Codification & designing process

For the system, Santiago was divided into ten areas (an area corresponding to a group of two to four counties). Each area was assigned a color and letter, and its buses would be operated by a local bus line that ran only within that area (Feeders). All local buses of a particular area were to be painted in the assigned color and named with a letter and a two digit number (i.e. B15). The ten areas would be connected by a network of main buslines (Trunks) which generally ran over the main avenues of the city.



Transantiago's particular color codification.

All trunk bus liveries were coded uniformly with Transantiago's corporate colors. Although authorities consider the metro network as a main trunk line, the team decided to treat it differently, keeping its historical color coding. Since one of the challenges in constructing this kind of map consists in establishing clear relationships between detailed information found in the environment, and abstract / conceptual structures contained in the plan (Casakin et al. 2000), the design of the Network Map followed the codification defined for the system.

Defining the map "style"

For many years, Santiago's metro diagram was the only official representation of the city transport network and therefore the only reference for public transport users. As in most subway diagrams, all lines were drawn as straight lines with fixed angles, emphasizing the connection between stations. Geographical and urban landmarks such as the Mapocho river and some avenues were not included on the metro map.

First schematic version of Transantiago Map

A semi-topographical version of Trabsantiago Map

Detail of on of the samplers tested

According to literature (Morrison, 1996; Mijksenaar, 1999, Avelar et al., 2006, etc.) and general practice, this kind of diagram is generally unsuitable for bus networks. Lines on diagrams cannot be easily related to the reality of the streets, nor therefore to the plan of the city that shapes the bus traveller's mental maps. For this reason, most transport authorities use bus maps that maintain a certain topographical relation to the city.

The need to evaluate which design approach (diagramatic or topographic) could better represent the Transantiago's multi modal network turned out to be relevant in resolving the structure of the new network map.

Two versions of the network maps were designed and tested simultaneously. The first was a single diagram with a schematic representation of the main lines (trunks) and the metro network. The second was a semi-topographical approach that presented in a whole piece trunks, metro and local buses.

Although the pieces had different design approaches, both sets of test network maps shared the same codification in order to evaluate possible connections between transportation modes. The testing phase used 7 focus groups with different kinds of potential users. It provided a better understanding of users' ability to navigate with maps and obtained some valuable inputs for the design of the final map.

Among the issues and abilities tested were:

- Self location
- Origin and destination
- Area recognition
- Mode recognitions
- Interchange station recognition
- Alternatives Route planning
- Places and landmarks recognition
- Identification of the city
- Aesthetic value.

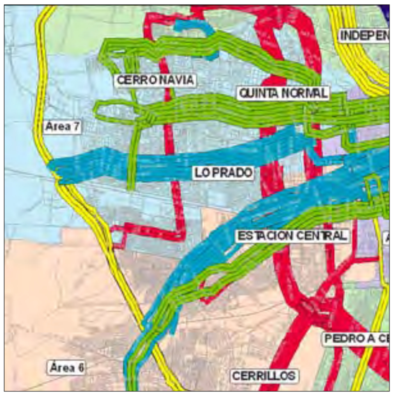
Among the main outcomes:

- Users were not familiar with reading maps.
- Users were not familiar with Santiago's topography.
- Users were not familiar with finding and following routes.
- Neither the diagrammatic nor the topographic version was entirely appropriate (a hybrid version was suggested).
- Users demanded geographical and urban references (especially local landmarks such as hospitals, parks and shopping malls).
- Users were not familiar with some of the graphic solutions usually utilized in maps, such as insets, to show congested areas.

According to Morrison classification and its characteristics, Transantiago's schematic map was situated between the Classic and the Scandinavian styles.

Translating GIS and Defining Routes

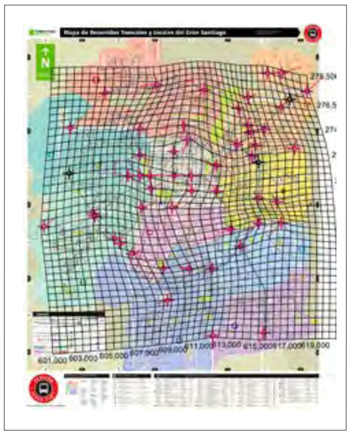
GIS maps are quite powerful and useful tools of representation, assisting engineers and planners to create models and organize complex networks. However, they do not necessarily facilitate the presentation of information for general public. Although Transantiago's engineers provided many route maps generated by this geographic system, most were too intricate and confusing for common users, especially in those zones when many lines overlap. Routes in Transantiago's final map were drawn one by one following a route list that contained the sequence of street names for each line. Although the process was tedious and slow, it was easier to determine the direction of the bus, detect which streets appeared overloaded with information and eventually make needed graphic adjustments.



GIS map with Transantiago's services.

Distortions

Without abandoning main geographical relationships and proportions, Transantiago's map incorporated some generalization and distortion techniques commonly applied in this kind of visual instrument, for example stretching the metropolitan area and compressing peripheral-suburban areas. These distortions improved readability and facilitated information selection in the most crowded parts of network without loosing topology.


Transantiago's map geometric distortion grid through MapAnalyst

Information Density

The combination of different information layers in a map not only enriches its content but also simplifies its design and editing. As Mijksenaar (1999) argues, a main task for map designers is to give these layers sufficient distinction within a harmonious whole. The first edition of Transantiago's map considered more than 70 layers, organized on an operative basis. This structure becomes especially important since the network is constantly changing and upgrading its routes. As a matter of fact, Transantiago's final routes were only defined two months before its launch in February, 2007, and in its first year, the map was released three times following changes in the network.

Among the factual information Transantiago's schematic map contains are: 10 areas. 34 counties. 182local bus routes (Feeders). 60 main local routes (Trunks.) 5 metro lines. 36 interchange stations / points. 89 metro stations.Hundred of main streets and avenues. Urban landmarks such as hospitals, townhalls, airports, museums, shopping centres. Natural landmarks such as rivers, hills, canals, parks. And other operational references, such as customer offices and recharging points for the "bip!" card.

Color Coding

Colors is a map dilemma; it can help or hurt a map and its interpretation. (Monmonier, 1996) After years spent struggling with the uniformity of the yellow Micros, color-coding turned out to be one of the user's main requests for the new navigation system, especially because it could simplify the recognition and discrimination of their buses.

Detail of Transantiago' map

Two main conditions were originally considered in defining Transantiago chromatic code: colors had to be easy to distinguish and had to be easy to name (i.e. "red"/ "blue").

Some conflicts began when colors were assigned to Transantiago's areas. Even Metro lines in Santiago are labeled by numbers, (i.e. Linea 1, Linea 2), and they historically have been represented in the Metro's diagram with colors. In order to avoid confusion, no areas' colors could match the color of a metro line that passed within its limits. Finally, the designation of a color to an area had economic implications since some pigments in vehicle painting are more

Detail of Transantiago' map

expensive than others. Because all buses that belong to an area should be colored, those areas with more buses were assigned one of the less expensive colors to avoid unnecessary expense.

The Network Map follows the same chromatic principle of Transantiago codification, with a few adjustments when colors are used in the background (23% to 27% of the original color) in order to facilitate legibility. All trunk services were coded in black to avoid conflict with Areas' colors.

Defining landmarks, naming and placing Most of Santiago's historical and tourist landmarks are located downtown or in the wealthier areas of the city (NE). The segmented nature of the city, along with an uneven distribution of landmarks on the map, could emphasize this division.

A group of historians, sociologists and urban planners developed a list of landmarks and names that could be placed, not solely homogeneously but fairly (from 16 landmarks in Area J to 36 landmarks in Area C). The landmark list was built up using interviews in each area, historical records, tourism guides, and with a complete photographic catalog of Micros signs especially, created for the study.

The final guidelines also considered a naming protocol to unify denominations, since same places in the city were often called differently. When possible, the most popular name was selected whether or not this was the official denomination.

Size Although it could seem insignificant, defining the size of the map was also not an easy task. Usability and production limitations, among other issues, needed to be considered. Since the map was supposed to be a portable booklet, its format was defined according to its legibility (the smallest legible typeface point), its portability and handling. The map final format is 80 x 68 cms (opened).

Transantiago's implementation became a social and a political failure and probably one of worst public-policy implementations in the country in the last two decades

Transantiago's Implementation

Transantiago's implementation has been tortuous. Its execution became a social and a political failure and probably one of worst public-policy implementations in the country in the last two decades. Some bus operators have not put out the required fleet, making bus service irregular and generating large crowds and long queues outside Metro stations and at bus stops. The fleet management software (which includes the use of GPS) has not been implemented. Separate bus corridors have also not been constructed, and "paid zones" have been improvised. The users' lack of trust in the bus system has overcrowded the Metro. There is also criticism of a lack of line coverage in the city's peripheral areas, which were well covered under the previous 'Micro" system.

In the meantime, "Transantiago Informa" – the operator in charge of managing information – has assumed more of the role of an advertising agency than an information provider, promoting Transantiago as a commercial product rather than providing information about a public service.

Transantiago's navigation system has been barely or poorly implemented as well. Few information pieces have been produced and installed according to the original standards. The guidebook version accessible online is outdated and the lack of control in the application of the norms has already produces several graphic misinterpretations and distortions.

Even though initially the network map received many complaints regarding its "infinite complexity" (The Economist, 2007), over time it has become one of the only reliable information instruments in the whole system. In fact, most users who were forced to learn how to read it without previous experience or instruction are actually demanding the new, upgraded version.

Transantiago has become a political issue and a social crisis. While support for president Michelle Bachelet has fallen drastically and a new Minister of Transportation is struggling to keep the system out of bankruptcy, passengers are experiencing real frustration and stress.

Regardless of the quality of the original design, Transantiago's chaotic implementation has condemned the whole system, including its navigation system and most of its components. Problems such as this, though, are not new; commenting on Vignelli's 1972 navigation system for the New York transport network, designer Eric Spiekermann pointed out that:

"One diagram, however perfect, cannot replace a comprehensive, integrated system of information(...). The problem for us [designers] is always that the success of our work gets judged not by our good intentions, nor our grand plans, but by what gets implemented. And that, more often than not, happens without and sometimes even against our advice." (Spiekerman. 2004)

Although the Navigation System has been one of the components less affected by the aftershock of Transantiago's "Big-Bang", substantial changes in the network and new conditions defined by transport authorities are requiring a complete revision of its original design and a drastic change in users' information strategy.

Navigation in public transportation networks requires a massive learning process, particularly in new systems, where users are not accustomed to being informed. While instructional resources must be used to increase users' understanding of the network (complementing current engaging actions), a long-term information design policy – which includes periodic evaluation of the navigation system, measuring user responses and performance – should be implemented. Transport planning is a continuing process, and its strategy is therefore not a one-for-all-time exercise (Wells, 1975), something authorities and operators must realize. Permanent assessment entails access to updated, reliable information and, more important, active informed users.

At present, the evaluation of many aspects of the original project is still pending. The incomplete implementation of the plan makes the evaluation of separate components inappropriate since the system was conceived as an interdependent whole. Additionally, the present general antipathy towards Transantiago certainly would bias any study of its users' satisfaction. Nevertheless, further studies could be done in order to estimate the real value of, for example, the local references on the maps and the cultural practices introduced by the project (ie: in the typeface and in the map) and how these elements affect the extent to which users are learning about or identifying with the system.

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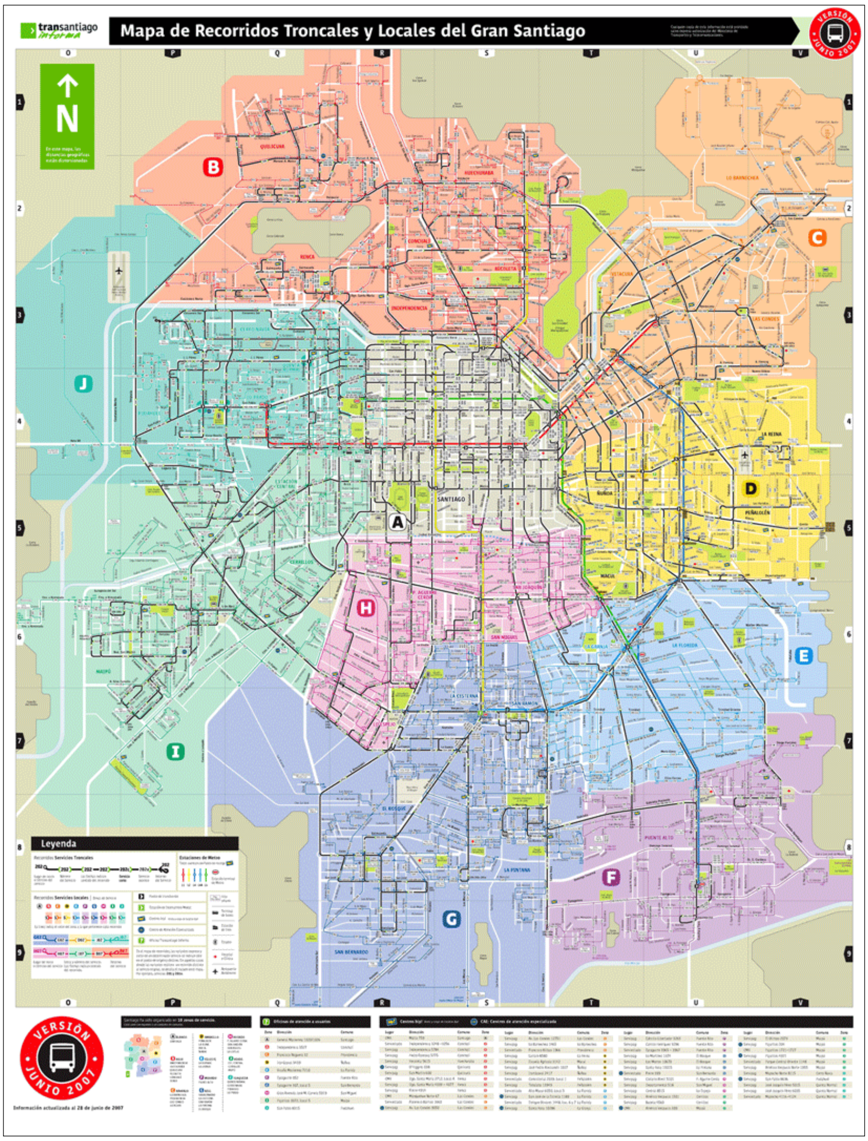
Complex problems – such as the design of Transantiago's map – have became messier and more ambiguous as transport systems strive to be more regularized and comprehensive; they are more connected to other problems; they are more likely to react in unpredictable, non-linear ways; and they are more likely to produce unintended consequences (Burns et al., 2006). Independent of the design quality of the project, its final result becomes highly dependent on a sum of multiple variables – many of them arbitrary or deeply rooted in local and cultural conditions. Achieving a measurable result under these conditions becomes a difficult task, especially under a conventional project base model.



Transantiago's Network Map. December, 2007

Chapter 10
Conclusion

The analysis of literature and the results that emerged from the cases studied, evidence the fundamental role of designers in defining today's graphic representation of public transport systems. This not only explains the diversity of maps, but also illustrates the lack of design standards.

While there is a tendency towards design regularization manifested in several attempts –mainly from computer scientists, transport agencies, and some mapmakers- to automatize and normalize map's creation according to prescript principles and models (i.e. cartographic and schematic),
there is also a trend towards more flexible solutions as a consequence of the growing complexity of transport systems and increasing demand for intermodality (i.e "hybrid maps").

The review of cases, such as the London Underground Diagram and the New York Subway map, puts in evidence designers' differences and demonstrates the inapplicability of universal design solutions for this kind of maps. The wide range of graphic solutions observed in the international survey done for this research, also confirms this assertion.

In this thesis, the diversity in transport maps is not necessarily considered a negative attribute, as it might reflect particular features such as users' needs and contextual characteristics (i.e. landmarks) – all aspects difficult to standardize in printed maps. Nevertheless, this diversity does not guarantee suitable solutions, neither a respect for basic design or cartographic notions. The diversity and inconsistencies found in maps is mostly seen as an unnecessary source of user confusion. (Cain 2007).

The international case survey also puts into evidence common graphic features, strategies and design techniques among different maps. The definition of a design framework -built on basic cartographic aspects- has facilitated the identification of these features, its classification and the analysis of their main graphic attributes. The comparative analysis of cases has also made possible the recognition of design operations (generalizations), conscious or unconsciously used by mapmakers worldwide to solve recurrent design issues.

The definition of this framework not only has facilitated the analysis of maps, but also provides a graphic repertory of symbols and design techniques that can benefit mapmakers' decisions.

This thesis compiles and proposes graphic guidelines that might support the design of public transport maps. These guidelines have been conceived not as a norm but as a set of recommendations that recognize the graphic and non-graphic dimensions of this discipline, bridging empirical evidence with graphic craftsmanship.

Further Steps

Some possible extensions or future research from this thesis could be regarding the following issues. These issues have been divided in three main aspects:

• The accessibility of users with different requirements seems to be an important goal of major transport agencies worldwide. The recent development of studies and reports in this direction not only demonstrates a trend toward the improvement of travelers' experience, but the importance of printed material in providing information aid.

The massive integration and exchange of multicultural users to transport systems –especially from emerging countries- will probably push forward the establishment of international protocols and the definition of certain graphic conventions in Public Transport Maps. Although some cities already consider versions of their maps translated in different languages, travelers still have to learn a whole set of graphic keys every time they get to a new city. Additionally, most of the time Public Transport Maps tend to be projected following local spatial references and topological conventions, which are not necessarily evident for newcomers.

Therefore the design of future Public Transport Maps will have to adapt to different languages, different educational and cultural backgrounds, and different users' characteristics. For these reasons, this task should be approached as an interdisciplinary endeavor, considering the participation of social, behavioral and cognitive experts. The evaluation of the graphic elements and design operations discussed in this thesis can be used as the base to conduct such studies.

• The integration of transport modes and networks is already stressing the integration of user information systems and communicational platforms- and therefore, their graphic representation.
The selection of a design strategy depends significantly on the complexity of the transport network. Public Transport Maps have to be able to reflect the integration of modes and systems- managing graphically a larger number of variables- without loosing its functional and graphic integrity. This integration will demand for mapmakers to review and conciliate different graphic strategies. Further experiments and evaluations in multimodal maps should be carried out.

• The rapid development of technologies based on geographic information systems (GIS) such as modeling software and portable navigation devices, are also introducing new variables and opportunities in the design of Public Transport Maps. Today's software can easily separate and store different layers of information and automatize some steps of the design, such as the schematization of lines and label placement. Engineers and computer programmers are developing powerful applications in which algorithms can render and update diagrams of transport networks in a fraction of the time employed by a designer with conventional computer assistance.

For the moment, the visual quality of automatic generated maps appears to be behind traditional Public Transport Maps and still unsuitable for large audiences. Regardless the media, the graphic knowledge and craftsmanship accumulated in more than a century of Public Transport Maps should not be discarded. In this sense, designers and computer scientists have a lot to learn from each other.

The compilation and dissemination of design experiences seems to be crucial in bridging the gap between designers, cartographers, computer scientists and all of those engaged in the design and study of Public Transport Maps. The establishment of an operative platform in which experiences, resources and tools could be exchanged among mapmakers worldwide, is desirable. Such a platform (i.e. a website) could contribute to the generation of a multidisciplinary discussion on the subject and –eventually- to the establishment of an expert community.

The development of a bibliography and guidelines (not standards) such as the one compiled in this thesis can be considered a starting point for further contributions and upgrades.

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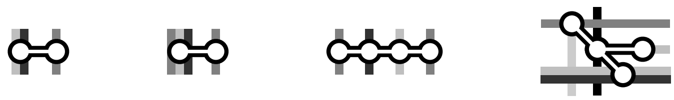
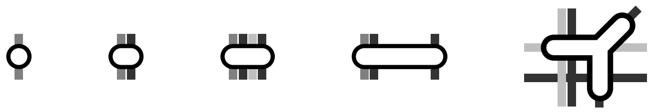
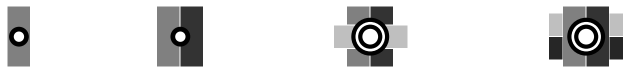
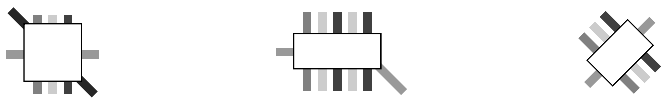
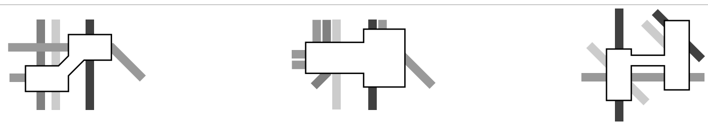
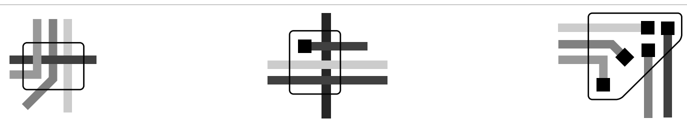
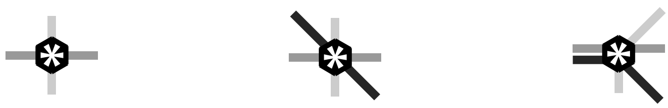
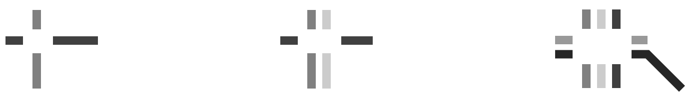
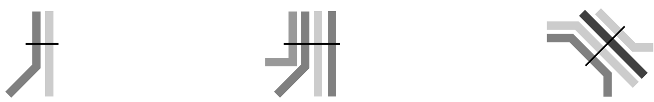
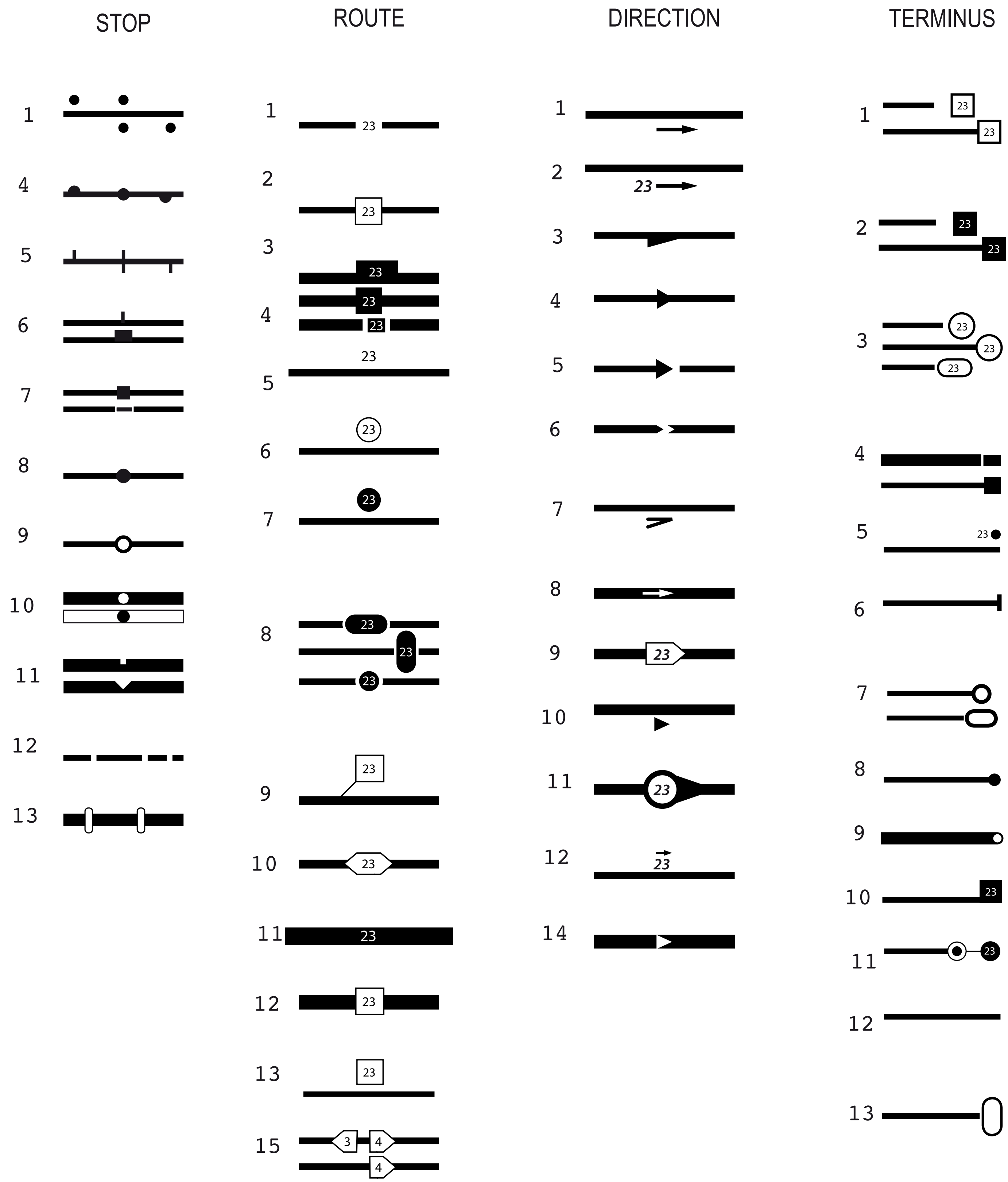
Annex 1

Graphic Inventory of Maps Symbols

Interchange Stations

Ring	
Rings Connected	
Rings Stressed	
Concenric Rings	
Dot	
Regular Polygon	
Iregular Polygon	
Pie	
Color Overprint	
Area	
Pictogram	
Blank Space	
String	

SYMBOL


STOP
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ROUTE
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DIRECTION
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TERMINUS
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Annex 2
Survey Table

MAP TABLE 07/01/09

CITY					MAP						GRAPHIC ELEMENTS																DOCUMENT PROPERTIES					
											Projection/Structure			Point Symbols			Line Symbols			Area Symbols		Typography										
Continent	Country	City	Population	Area (km2)	Institution	System	Year	Source	Modes	Modes	Style	ality/Abstracti	Fixed Angles	Stop/Station	Interchange	Landmarks	Directionality	Nº Line's Colors	Streets/Ave.	Background A	Geographic Reference	Fonts	ation Orientati	oute Labellin	oute Orientati	Terminus	Doc. Name	Format (cm)	Kind of Doc	Software	Doc. Size (KB)	Designer/Author
Europe	Netherlands	Amsterdam	1.468.122	219	GVS	Lijnennetkaart/	-----	www.gvb.nl	4	Metro-Rail/Tram/Bus/Fer	French	1		4	11,4	Pictograms	2	4	Highways & Ave	Geographic Ref	Water & Land	Courier/Univers	0º	4	Free	11	lijnennetkaart0	69.128 x 50.080	F/QuarkXpre	-----	1.230	-----
Europe	Netherlands	Amsterdam	1.468.122	219	GVS	Lijnennetkaart /	-----	www.gvb.nl	1	Bus	French	2	-----	4	3	-----	1	4	None	Geographic Ref	Water & Land	Courier/Linotyp	-----	-----	-----	7	lijnennetkaart0	-----	F/QuarkXpre	-----	1.230	-----
Europe	Greece	Athens	3.761.810	411	OASA (Athe	-----	-----	www.oasa.gr	2	Metro-Rail/Bus	Combination	1	-----	9	4	Pictograms	8	7	Highways & Ave	Geographic Ref	Water & Land	Antique Olive/H	-----	8	0º	Other	ATHINA2007	299.965 x 299.965	F / CorelDr	CorelDraw	2.088	Charich
Europe	Greece	Athens	3.761.810	411	ATTIKO ME	thens Metro dev	-----	www.ametro.gr	1	Metro-Rail	French	1	-----	9	Other	-----	N/A	6	None	Geographic Ref	Water & Land	-----	0º	-----	Free Curve	7	AM-Athens-met	42.011 x 29.700	PDF	Acrobat Distill	681.460	-----
North America	USA	Atlanta	486.411	343	MARTA (Me	Metropolitan Atl	2007	www.itsmarta.c	2	Metro-Rail/Bus	Combination	1	-----	9	1	Generic Point	8	9	Main Streets	Geographic Ref	Water & Land	Frutiger/Helvet	0º	7	0º	-----	080607-TPB-Ex	93.969 x 60.318	PDF/	FreeHand 10	734	-----
North America	USA	Atlanta(2)	486.411	343	MARTA (Me	Metropolitan Atl	2007	www.itsmarta.c	2	Metro-Rail/Bus	Combination	1	-----	9	-----	Generic Point	8	9	Highways & Ave	Geographic Ref	Water & Land	Frutiger/Helvet	0º	7	0º	-----	080607-TPB-Ex	93.969 x 60.318	PDF/	FreeHand 10	734	-----
Europe	Spain	Barcelona	1.605.602	100	TMB (Trans	Integrated Railw	2007	www.tmb.net	4	Metro-Rail/Funicular/Tele	French	3	0º/30º/45º/90º	6	3	Pictograms	N/A	15 or More	None	Geographic Ref	Water & Land + North	Helvetica	0º	-----	-----	6	genplano.pdf/T	41.116 x 29.605	F/FreeHand	-----	180	-----
Europe	Spain	Barcelona	1.605.602	100	TMB (Trans	Urban bus of Ba	-----	www.tmb.net	4	Metro-Rail/Bus/Funicular	French	3	0º/30º/45º/90º	9	-----	Illustration	9	15 or More	Main Streets	Geographic Ref	Water & Land	-----	-----	12	Fixed Angles	4	Transporte públ	-----	Papel	-----	-----	-----
Europe	Switzerland	Basel	165.529	23	BVB	Liniennetz Base	2006	www.bvb-basel	2	Bus/Tram	French	3	0º/30º/45º/90º	10	3	Thematic Pictog	13	10	None	Tariff & System	Water & Land	-----	0º	10	Fixed Angles	10	Basel_Umgebun	20.998 x 29.697	dobe Illustrat	Illustrator CS2	970	-----
Europe	Germany	Berlin	3.410.000	892	BVG	S/U Netz	2007	www.bvg.de	2	Metro-Rail/Tram	French	3	0º/45º/90º	6	3	-----	N/A	15 or More	None	Tariff & System	None	GenBVG/GenTr	0º	-----	-----	Other	S+U-Bahn_091	41.976 x 29.700	PDF	FreeHand 9	116	BVG
Europe	Germany	Berlin	3.410.000	892	BVG	M/Tram Netz	2007	www.bvg.de	2	Metro-Rail/Tram	French	3	0º/45º/90º	6	3	-----	10	15 or More	None	Tariff & System	None	GenBVG/GenTr	Fixed Angles	5	Fixed Angles	Other	TramMetro_akt	41.976 x 29.700	PDF	FreeHand 9	130	BVG
Europe	Spain	Bilbao	354.145	41	Metro Bilba	Bilbobus	2007	www.metrobilb	1	Metro-Rail/Tram/Bus	Classic	1	-----	-----	11	-----	N/A	15 or More	Highways & Ave	Geographic Ref	Water & Land	Helvetica	-----	6	0º	Other	marquesina.pdf	75.838 x 114.251	PDF	-----	513	-----
South America	Colombia	Bogota	7.033.914	1587	Transmileni	-----	-----	www.transmile	1	Metro-Rail	French	3	0º/45º/90º	10	2	Illustration	N/A	9	Highways & Ave	Geographic Ref	Land + North	-----	Fixed Angles	-----	-----	2	N/A	-----	JPG	-----	-----	-----
North America	USA	Boston	590.763	232	MBTA (Mass	System Map: Of	2006	www.mbta.com	3	Metro-Rail/Bus/Boat	French	1	-----	Other	11	Illustration	1	15 or More	Street Map	Geographic Ref	Water & Land	Helvetica/Palat	-----	7	0º	8	MBTA-system_m	-----	PDF	-----	1.800	-----
North America	USA	Boston	590.763	232	MBTA (Mass	Rapid Transit an	2006	www.mbta.com	3	Metro-Rail/Boat	French	3	0º/45º/90º	10	2	-----	N/A	7	None	Geographic Ref	Water & Land	Helvetica/Palat	Fixed Angles	-----	-----	7	MBTA-system_r	-----	PDF	-----	1.800	-----
South America	Brazil	Brasilia	2.455.903	5802	N/A	-----	-----	www.metro.df.g	1	Metro-Rail	French	1	-----	9	-----	-----	N/A	2	None	Geographic Ref	Water & Land + North	-----	0º	-----	-----	-----	N/A	-----	JPG	-----	452	-----
Europe	Belgium	Brussels	1.100.000	242	STIB/MIVB	N/A (Network)	2008	www.stib.be	3	Metro-Rail/Bus/Tram	French	1	-----	5, 9	2	Pictograms	Other	15 or More	Street Map	Arbitrary	Water & Land + North	Brusseline/Futu	0º	3	Free	4	20080211_plan	49.994 x 49.994	PDF	Adobe Illustra	1.670	-----
Europe	Belgium	Brussels	1.100.000	242	STIB/MIVB	N/A (Metro)	2007	www.stib.be	2	Metro-Rail/Tram	French	3	0º/45º/90º	9	1	-----	N/A	9	None	-----	None	-----	Fixed Angles	-----	-----	2	20070702_Plan	59.993 x 39.995	PDF	Adobe Illustra	1.130	-----
Europe	Romania	Bucharest	2.082.000	226	RATB	Reteaua de Tran	2007	www.ratb.ro	3	Bus/Tram/Troley	Classic	2	-----	-----	-----	Pictograms	N/A	15 or More	Main Streets	-----	None	Times New Rom	-----	5	Free Curve	Other	generala.pdf / F	42.011 x 29.700	PDF	PScript5.dll	112.41	E_Dumitrescu
Europe	Hungary	Budapest	1.696.128	525	BKV	Reteau de Trans	2007	www.bkv.hu	2	Bus/Tram	French	3	0º/45º/90º	10	1,7	-----	3	15 or More	None	-----	Water	Arial MT/Arial N	Fixed Angles	11	Fixed Angles	Other	BKV_laratlista2	-----	PDF	Adobe Indesig	2.680	dtp
South America	Argentina	Buenos Aires	3.034.161	203	Subte / Me	-----	-----	www.subte.com	1	Metro-Rail	French	3	0º/45º/90º	10	2	-----	N/A	7	Highways & Ave	-----	Water	Frutiger	Fixed Angles	-----	-----	10	mapasubte	39.683 x 22.222	PDF	Adobe Illustra	100.99	-----
South America	Venezuela	Caracas	2.762.759	1930	Metro	Rutas del Sister	2007	www.metrodeca	2	Metro-Rail/Bus	French	3	0º/45º/90º	6	4	-----	N/A	4	None	-----	Water	Arial/TimesNew	Fixed Angles	-----	-----	6	Esquematico M	27.478 x 19.118	crosoft Powe	-----	15	Gdiaz
North America	USA	Chicago	2.833.321	606	CTA (Chicag	System Map	2009	www.transitchi	2	Metro-Rail/Bus	Combination	1	-----	9	2	Generic Point	5	13	Highways & Ave	Geographic Ref	Water & Land + North	Frutiger/Helvet	0º	7	0º	8	SystemMap_20	-----	PDF	-----	-----	-----
North America	USA	Chicago	2.833.321	606	CTA (Chicag	Rail System (Th	2009	www.transitchi	1	Metro-Rail	French	3	0º/30º/45º/90º	9	2	-----	N/A	9	None	Geographic Ref	Water + North	Frutiger/Helvet	Fixed Angles	4	Fixed Angles	10	SystemMap_20	-----	PDF/	-----	-----	-----
North America	USA	Cleveland	444.313	213	RTA (Greate	RTA System Ma	2007	www.gcrta.org	2	Metro-Rail/Bus	Classic	1	-----	-----	-----	Pictograms	4	5	Highways & Ave	Geographic Ref	Water & Land + North	Arial/Helvetica/	-----	4,2	Free	-----	System_Map_M	66.667 x 60.953	PDF	FreeHand MX	249	David Clawson
Europe	Denmark	Copenhagen	1.145.804	88	DSB	-----	-----	www.dsb.dk	1	Metro-Rail	French	3	0º/45º/90º	6	13	-----	N/A	7	None	Tariff & System	None	Times/ViaOffice	Fixed Angles	3	Fixed Angles	2	S-tog.pdf	20.498 x 20.998	PDF	Adobe Indesig	780	-----
South America	Brazil	Curitiba	1.788.559	434967	URBS (Urba	-----	-----	www.urbs.curit	1	Bus	Combination	3	Other	9	3	-----	2	6	None	-----	None	-----	Fixed Angles	11	0º	7	N/A	916 x 604	JPG	-----	452	-----
Asia	India	Delhi	13.782.976	1483	Metro Rail	-----	-----	www.delhimetrorail.com	1	Metro-Rail	French	1	-----	9	-----	-----	N/A	3	Street Map	Politic	Water & Land	-----	Free	-----	-----	Other	N/A	726 x 586	JPG	-----	908	-----
Europe	UK	Dundee	143.090	67	Dundeetrav	Bus Services in	2005	www.dundeetra	1	Bus	Combination	3	0º/45º/90º	9	2	Generic Point	13	15 or More	Highways & Ave	Geographic Ref	Water & Land	Frutiger/InfoDi	0º	3,12	0º	7	dundee_networ	52.309 x 24.772	PDF	CorelDRAW V	165	SDG
North America	Canada	Edmonton	730.372	264	ETS	Day Map	2008	www.edmonton	2	Metro-Rail/Tram/Bus	Combination	1	-----	-----	-----	Pictograms	2	3	Street Map	Geographic Ref	Water + North	Arial/FuturaBT	0º	4	Free	-----	day_map_febr	59.401 x 65.926	PDF	Illustrator CS	1.290	-----
Europe	Italy	Florencia	366.488	39	ATAF	-----	2007	www.ataf.net	1	Bus	Combination	3	0º/30º/45º/90º	-----	-----	Illustration	10	8	Highways & Ave	Tariff & System	Water	Clarendon/Helv	0º	3	0º	3	Mappa_rete.pdf	29.700 x 20.988	PDF	Illustrator CS	257	-----
Europe	Germany	Frankfurt	5.800.000	248	RMV / VGF	Schnellbahnplan	2007	www.rmv.de	1	Metro-Rail	French	3	0º/45º/90º	9	-----	Pictograms	N/A	12	Highways & Ave	-----	None	LinotypeUnivers	Fixed Angles	-----	Free	7	PLA_Schnellba	59.393 x 41.395	PDF	FreeHand MX	176	Rhein-Main-Verkehrsve
Europe	Germany	Frankfurt	5.800.000	248	RMV / VGF	TraffiQ: Linienne	2008	www.rmv.de	1	Metro-Rail	French	2	-----	2	12	Pictograms	N/A	10	None	Tariff & System	Water	HelveticaNeue	Fixed Angles	4	Free	3	traffiQ_Linienne	41.995 x 29.697	dobe Indesi	-----	983	-----
Europe	Switzerland	Geneva	185.726	13	TPG Transp	-----	2007	www.tpg.ch	3	Metro-Rail/Bus/Boat	French	2	-----	7	Other	Pictograms	9	15 or More	Main Streets	Tariff & System	Water + North	Frutiger/ Univer	0º	3	Free	2	TPG-Plan_12-07	67.935 x 59.008	PDF	Illustrator CS2	8.090	-----
Europe	Italy	Genova	615.686	243	AMT	Mappa dei Trasp	2006	www.amt.genova	1	Bus	Combination	1	-----	-----	-----	Pictograms	12	8	Main Streets	Politic	Water & Land	-----	-----	3	Free	4	mappa_Ge_tras	75.768 x 65.997	PDF	-----	2.100	-----
Europe	UK	Glasgow	1.750.000	176	SPT	Local rail service	2007	www.spt.co.uk	1	Metro-Rail	French	3	0º/45º/90º	6	1	-----	N/A	12	None	Geographic Ref	Water	AvantGardeITC	0º	-----	-----	6	Rail network_20	29.697 x 20.998	dobe Illustrat	-----	578	SPT
Europe	UK	Glasgow	1.750.000	176	SPT	Glasgow Networ	2007	www.spt.co.uk	1	Bus	Combination	3	-----	10 y N/A	-----	Generic Point	12	15 or More	Main Streets	Geographic Ref	Water & Land	HelveticaNeue/	0º	4	Free Curve	10	mapmate.pdf	62.993 x 44.395	PDF	-----	513	-----
Europe	UK	Glasgow	1.750.000	176	SPT	Over Ground: Fr	2006	www.spt.co.uk	1	Bus	French	3	0º/45º/90º	5	13	-----	1	15 or More	None	Geographic Ref	Water	HelveticaNeue	0º	-----	-----	2	glasgowovergro	42.011 x 29.700	F/FreeHand	-----	62	Moira Bantock
Europe	Germany	Hamburg	1.766.156	755	HVV	Rapid Transit/Re	2007	www.hvv.de	1	Metro-Rail	French	3	0º/45º/90º	11	6	-----	N/A	8	None	Arbitrary	Water	Myriad	Fixed Angles	7	0º	3	hvv_usar_regio	43.477 x 31.178	Design CS2	-----	559	wolfdietergreuel
Europe	Germany	Hamburg	1.766.156	755	HVV	HVV Metro Buse	2007	www.hvv.de	1	Bus	Classic	1	-----	-----	-----	-----	N/A	3	Street Map	Geographic Ref	Water & Land	Frutiger/Myriad	-----	4	0º	2	HVV_Produktpl	41.976 x 29.665	PDF	-----	1.790	-----
Europe	Germany	Hannover	1.128.543	204	GVH	Stadtbahnnetz	2006	www.gvh.de	1	Metro-Rail	Combination	3	0º/45º/90º	11	13	-----	N/A	4	None	Geographic Ref	Water	Frutiger/ Ustrat	Fixed Angles	4	0º	2,11	2007_Stadtbahn	29.700 x 20.996	PDF	-----	154.52	-----
Europe	Finland	Helsinski	568.146	187	HKL	Bussilinjar; Esik	2006	www.hel.fi/wps	4	Metro-Rail/Bus/Tram/Fer	Classic	1	-----	1	-----	-----	N/A	5	Street Map	Geographic Ref	Water & Land	HelveticaNeue/	-----	4	0º	5	kartta_35_buss	77.002 x 46.208	PDF	-----	2.190	-----
Europe	Finland	Helsinski	568.146	187	HKL	Raitiolinjat la ke	2006	www.hel.fi/wps	1	Tram	French	1	-----	3	3	Pictograms	12	8	Street Map	Geographic Ref	Water & Land	HelveticaNeue/	-----	4	0º	8	kartta_20_ratik	36.191 x 45.997	PDF	-----	759	-----
Asia	Hong Kong	Hong Kong	6.963.100	686	MTR	System Map	2008	www.mtr.com.h	1	Metro-Rail	French	3	0º/45º/90º	9	3	Thematic Pictog	N/A	11	None	Geographic Ref	Water & Land	-----	0º	-----	-----	7	MTR_routemap	21.469 x 15.399	Acr1614233	-----	3.500	-----
Asia	Hong Kong	Hong Kong	6.963.100	686	MTR	Light Rail Route	2008	www.mtr.com.h	1	Metro-Rail	French	3	0º/90º	3	3	Pictograms	8	14	None	Tariff & System	None	-----	0º	-----	-----	7	MTR_routemap	21.469 x 15.399	Acr1614233	-----	3.500	-----
Europe	Turkey	Istanbul	11.912.511	1539	IstanbulUla	Rail System Net	-----	www.istanbul-u	1	Metro-Rail	French	3	0º/45º/90º	6	2	Pictograms	1	7	None	Geographic Ref	Water	-----	Fixed Angles	-----	-----	7	istanbulRaylSi	42.011 x 29.700	PDF	-----	162.73	tanoren
Europe	Turkey	Istanbul	11.912.511	1539	IstanbulUla	Rail System Ge	-----	www.istanbul-u	1	Metro-Rail	French	2	-----	9	2	-----	N/A	6	None	Geographic Ref	Water	-----	Fixed Angles	-----	-----	7	cografiharitadB	42.011 x 29.700	PDF	-----	232.75	tanoren
Europe	Germany	Karlsruhe	285.812	173	KVV	Rail System Net	2006	www.kvv.de	2	Metro-Rail/Tram	French	3	0º/45º/90º	7	3	Illustration	4	14	None	Geographic Ref	Water	Frutiger/Helvet	Fixed Angles	10	Fixed Angles	2	kvvnetz.pdf/KV	42.046 x 29.418	PDF	FreeHand 10.	160.09	-----
Europe	Germany	Koln (Cologne)	991.395	405	VRS	Busnetz	2006	www.vrsinfo.de	2	Metro-Rail/Bus	French	3	0º/45º/90º	7	6	-----	Other	15 or More	None	Geographic Ref	Water + North	Frutiger/Helvet	0º	4	0º	2	1_9_2_Busnetz	39.995 x 38.995	PDF	Adobe Illustra	346.31	-----
Europe	Germany	Koln (Cologne)	991.395	405	VRS	Schnellverkehr	2008	www.vrsinfo.de	1	Metro-Rail	French	3	0º/45º/90º	6,3	6	-----	N/A	14	None	Geographic Ref	Water + North	Helvetica	Fixed Angles	4	0º	2	1_9_1_Schnelk	39.995 x 38.995	PDF	Adobe Illustra	925.97	-----
Europe	Germany	Leipzig	508.605	297	LVB	-----	2008	www.lvb.de	2	Bus/Tram	Combination	3	0º/45º/90º	3	3	Illustration/ The	N/A	5	None	Tariff & System	None	AvantGardeITC	0º	4	0º	2	LNP-klein-11.7	41.995 x 29.697	PDF	Adobe Illustra	1.250	-----
Europe	France	Lille	1.000.900	450	Transpole	-----	2008	www.transpole.	3	Metro-Rail/Bus/Tram	Combination	2	-----	9	3	Illustration	1	14	None	Geographic Ref	Water & Land	Metropolis	0º	3	Free	7	planjanv2008.p	79.991 x 59.993	PDF	Adobe InDesi	1.240	-----
Europe	Portugal	Lisboa	564.477	84	Metropolita	Network Diagra	2007	www.metrolisb	1	Metro-Rail	French	3	0º/45º/90º	10	9	-----	N/A	4	None	Geographic Ref	Water & Land	Metropolis	0º	-----	-----	10	diagrama2007.	29.697 x 20.998	PDF	Adobe Illustra	272.45	-----
Europe	Portugal	Lisboa	564.477	84	Metropolita	City Map	2007	www.metrolisb	1	Metro-Rail	French	1	-----	10	5	Illustration	N/A	4	None	Tariff & System	Water & Land + North	Futura	0º	-----	-----	10	mapa_rede_200	29.697 x 20.998	PDF	Adobe Illustra	2.070	-----
Europe	Portugal	Lisboa	564.477	84	Carris	Mapa de Rede C	2008	www.carris.pt	3	Metro-Rail/Bus/Funicular	Combination	2	-----	9	1,2,3	Thematic Pictog	N/A	11	Main Streets	Politic	Water & Land	LogosPiFont/NJ	0º	4,6	0º	8	Mapa Rede 200	69.489 x 83.457	PDF	-----	1.530	-----
Europe	UK	London	7.512.400	1577	Transport fo	Tube map: Ovst	2007	www.tfl.gov.uk	1	Metro-Rail	French	3	0º/45º/90º	6	2	Pictograms	N/A	11	None	Tariff & System	Water	NJFont/Univers	0º	-----	-----	7	Standard-Tube-	124.447 x 99.756	PDF	Adobe Illustra	326	Transport for London
Europe	UK	London	7.512.400	1577	Transport fo	[illegible]	2007	www.tfl.gov.uk	2	Metro-Rail/Bus	Classic	1	-----	9	1	Generic Point	1	11	Street Map	Geographic Ref	Water & Land	ITSN/ScalaSans	0º	4	0º	Other	Central-London	42.437 x 33.490	PDF	-----	345	Transport for London
North America	USA	Los Angeles	12.950.129	4.320	Metro (Los	12 Minute Map	2008	www.metro.net	2	Metro-Rail/Bus	Combination	3	0º/45º/90º	10	3	Generic Point	10	8	Main Streets	Geographic Ref	Water & Land + North	DIN	0º	3	0º	10	12min_map_en	62.244 x 43.274	PDF	Adobe InDesi	1.380	-----
North America	USA	Los Angeles	12.950.129	4.320	Metro (Los	System Map	2008	www.metro.net	2	Metro-Rail/Bus	Combination	2	-----	9, 10	3	Generic Point	13	15 or More	Highways & Ave	Geographic Ref	Water & Land + North	DIN	0º	4	0º	Other	system_map.pd	107.937 x 87.620	PDF	-----	1.360	Metro Communications
North America	USA	Los Angeles	12.950.129	4.320	Metro (Los	Metro Rapid	2008	www.metro.net	1	Metro-Rail/Bus	French	1	-----	9	-----	-----	N/A	3	Highways & Ave	Geographic Ref	Water & Land + North	Futura/Garamo	-----	-----	-----	Other	rapid_system_m	27.937 x 21.587	PDF	Adobe Illustra	1.460	Metro Planning
Europe	France	Lyon	470.000	48	TCL	Agglonération	2006	www.tcl.fr	4	Metro-Rail/Bus/Tram/Fer	Combination	1	-----	10	2	Pictograms	6	15 or More	Main Streets	Politic	Water	Helvetica/Memp	0º	3	Free	8	agglomeration.	96.193 x 78.203	PDF	FreeHand MX	975	TCL Transports en Com
Europe	France	Lyon	470.000	48	TCL	Métro - Tramwa	2008	www.tcl.fr	3	Metro-Rail/Tram/Bus	French	3	20º/90º	10	1	-----	N/A	10	None	Geographic Ref	Water	Helvetica/ Sym	0º	-----	-----	3	metro_tram.pdf	15.027 x 18.025	PDF	FreeHand MX	80	TCL : Transports en Co
Europe	Spain	Madrid	3.228.359	607	CTM (Conso	Red de Metro y	2008	www.ctm-madri	1	Metro-Rail/Tram	French	3	0º/45º/90º	6	3, 10	-----	N/A	13	None	Tariff & System	Water	FoundryGridnik	0º	-----	-----	2	metro_1.pdf/Es	28.197 x 30.696	PDF	FreeHand MX	405	-----
Europe	Spain	Madrid	3.228.359	607	CTM (Conso	Red de Metro y	2007	www.ctm-madri	2	Metro-Rail/Tram	French	3	0º/90º	6	2	-----	N/A	13	None	Geographic Ref	Water & Land + North	Myriad/Official	0º	-----	-----	12	Plano_Metro_Re	26.526 x 19.091	PDF	Adobe Illustra	1.600	ray (RaRo)
Europe	UK	Manchester	452.000	116	Metrolink	Greater Manche	2007	www.metrolink	2	Metro-Rail/Tram	French	3	0º/45º/90º	10	9	-----	N/A	15 or More	None	Politic	Water	OfficinaSans/Z	0º	-----	-----	10	GMPTERaildiag	29.697 x 20.998	PDF	Adobe Illustra	676.95	-----
Europe	UK	Manchester	452.000	116	GMPTE	-----	2007	www.gmpte.co	2	Metro-Rail/Tram	Classic	2	-----	10	1	Pictograms	12	2	Main Streets	Geographic Ref	Water & Land	OfficinaSans/Z	-----	4	Free	-----	manchester_ne	120.672 x 85.398	PDF	Adobe Illustra	5.320	-----
South America	Colombia	Medellin	2.223.078	381	Metro	-----	-----	www.metrodem	1	Metro-Rail	French	1	-----	10	6	-----	N/A	5	None	Geographic Ref	Water	HelveticaNeue	Fixed Angles	-----	-----	7	N/A	1009 X 391	JPG	-----	-----	-----
Oceania	Australia	Melbourne	3.744.373	37	Metlink	Melbourne Publi	2006	www.metlinkme	3	Metro-Rail/Bus/Tram	Combination	1	-----	N/A, 9 for trains	-----	Pictograms	13	10	Main Streets	Tariff & System	Water & Land	Helvetica	0º	4	Free	13	DetailTransport	20.996 x 29.700	PDF	-----	5.23	Daren
Oceania	Australia	Melbourne	3.744.373	37	Metlink	Melbourne Train	2007	www.metlinkme	1	Metro-Rail	Combination	3	0º/45º/90º	10	4	-----	N/A	2	None	Tariff & System	North	-----	Fixed Angles	-----	-----	9	Train Network_2	16.096 x 22.219	PDF	Adobe Illustra	402	-----
Oceania	Australia	Melbourne	3.744.373	37	Metlink	Melbourne Tram	2007	www.metlinkme	1	Tram	Classic	3	0º/45º/90º	10	-----	-----	N/A	3	Main Streets	Tariff & System	North	-----	Fixed Angles	10	Fixed Angles	7	Tram_Network.	20.996 x 29.700	PDF	Adobe Illustra	473	Helen Radloff
North America	Mexico	Mexico D.F.	19.231.829	1479	Metro de la	Red del Metro	2003	www.metro.df.g	1	Metro-Rail	French	2	-----	10	8	-----	N/A	10	Main Streets	-----	North	Century/Frutige	Free	-----	0º	3	redvobo9.pdf /	21.587 x 27.937	PDF	CorelDraw	16.36	S.T.C. metro
North America	USA	Miami	4.919.036	143	DADE	Miami-Dade Tra	2006	www.miamidad	3	Metro-Rail/Bus	French	2	-----	10 y N/A	-----	-----	13	15 or More	Main Streets	Geographic Ref	Water + North	Century/Frutige	0º	7	0º	Other	tm_for_web.pd	87.620 x 81.271	PDF	QuarkXPress	1.800	j u l i o
Europe	Italy	Milano	1.303.437	182	ATM	Rete metropolita	2005	www.atm-mi.it	1	Metro-Rail	French	3	0º/45º/90º	10	1,3	-----	N/A	6	None	Tariff & System	None	Garamond/Univ	Fixed Angles	-----	-----	10	mappametro.pd	64.992 x 44.995	PDF	Adobe Illustra	680	-----
Europe	Italy	Milano	1.303.437	182	ATM	Rete metropolita	2005	www.atm-mi.it	3	Metro-Rail/Bus/Tram	Combination	1	-----	10	1	Pictograms	4	5	Street Map	Geographic Ref	Water & Land + North	-----	0º	4	Free	-----	N/A	839 x 804	JPG	-----	608	-----
North America	Canada	Montreal	1.620.693	365	STM	-----	2007	www.stm.info	2	Metro-Rail/Bus	Classic	1	-----	9 y N/A	8	Pictograms	7	5	Street Map	Geographic Ref	Water & Land	Garamond/Univ	0º	-----	Free Curve	-----	reseau2007.pdf	178.788 x 83.253	PDF	Adobe Illustra	3.200	-----
North America	Canada	Montreal	1.620.693	365	-----	-----	2005	www.stm.info	1	Metro-Rail	French	3	0º/45º/90º	10	1	-----	N/A	5	None	Geographic Ref	North	-----	0º	-----	-----	10	plann-metro.pd	21.164 x 25.326	JPG	-----	228	-----
Europe	Russia	Moscow	10.462.424	1081	Metro	Rapid Transit Sy	2008	www.mosmetro	1	Metro-Rail	French	3	0º/45º/90º	9	2	-----	N/A	11	None	Geographic Ref	Water	-----	Fixed Angles	-----	-----	7	Picture1	35.375 x 40.101	JPG	-----	628	-----
Europe	Germany	Munich	1.348.650	310	MVV	Verkehrslinienpl	2008	www.mvv-mue	3	Metro-Rail/Bus/Tram	Combination	1	-----	9	1, 8	-----	4	6	Main Streets	Geographic Ref	Water & Land	Futura/Swiss72	0º	4	Free	7	vlp08stadt.pdf/	57.672 x 40.494	PDF	CorelDraw	816	MVV
Europe	Germany	Munich	1.348.650	310	MVV	Schnellbahnnetz	2008	www.mvv-mue	1	Metro-Rail	French	3	0º/45º/90º	6	3	Illustration/ The	N/A	11	None	Tariff & System	Water	VialogLT/Zurich	0º	-----	-----	6	schnellbahnnetz	29.771 x 21.058	PDF	CorelDraw	210	MVV
Europe	Germany	Munich	1.348.650	310	MVV	Tramnetz Münch	2007	www.mvv-mue	1	Tram	French	3	0º/45º/90º	6	3	Illustration/ The	N/A	10	None	Geographic Ref	Water	ArialMT/VialogL	0º	-----	-----	6	tramlinienplan	119.151 x 83.945	PDF	CorelDraw	207	fischer.helmut
Asia	Japan	Nagoya	2.190.549	326	Kotsu (City	-----	2008	www.kotsu.city	2	Metro-Rail/Bus	French	2	-----	9	1, 6	-----	N/A	7	None	-----	None	-----	0º	-----	-----	7	subwaymap	20.988 x 24.268	PDF	Photoshop 5.0	527.77	-----
Europe	Italy	Naples	975.139	117	Metro / CTP	-----	2008	www.metro.na.	1	Metro-Rail	French	3	0º/30º/45º/90º	11	1	-----	N/A	4	None	-----	None	-----	Fixed Angles	11	0º	Other	mappa_nuova	35.521 x 42.716	PDF	Photoshop CS	930.521	-----
North America	USA	New York	1.537.195	88	MTA (Metro	MTA New York C	2007	www.mta.info	2	Metro-Rail/Boat	Combination	1	-----	10	2,3	-----	N/A	11	Street Map	Geographic Ref	Water & Land + North	BulletFontNew/(	Fixed Angles	6	0º	2	subwaymap.pdf	55.513 x 69.644	PDF	Adobe Illustra	439	Chuck Gordanier
North America	USA	New York	1.537.195	88	MTA (Metro	MTA Manhattan	2007	www.mta.info	2	Metro-Rail/Bus	Combination	2	-----	9	-----	Generic Point	3,4	6	Main Streets	Geographic Ref	Water & Land + North	Garamond/Helv	0º	3	0º	4	manbus.pdf/Ma	27.619 x 85.080	PDF	-----	309	NYC Transit Mapping
Asia	Japan	Osaka	19.220.000	222	Kotsu	-----	2006	www.kotsu.city	1	Bus	French	2	-----	8	-----	-----	4	6	None	Geographic Ref	Water + North	FutoGoB101/Go	?	8	0º	8	bus.pdf/	14.584 x 17.501	PDF	Adobe Illustra	526	-----
Asia	Japan	Osaka	19.220.000	222	Kotsu/OKK	-----	2008	www.kotsu.city	2	Metro-Rail	Classic	3	0º/30º/45º/90º	9	3	-----	N/A	9	None	-----	None	-----	?	-----	-----	7	subway_no.pdf	29.697 x 20.998	PDF	Adobe Illustra	423.58	-----
Europe	Norway	Oslo	839.423	454	Sporveier	Busslinjer I Oslo	2006	www.sporveien	1	Bus	French	3	0º/45º/90º	-----	10	-----	5	12	None	Geographic Ref	Water	Frutiger	Fixed Angles	11	0º	8	BussAlleAug06w	18.998 x 18.998	PDF	Adobe InDesi	284.08	-----
Europe	Norway	Oslo	839.423	454	Sporveier	Lokaltog | T-bar	2006	www.sporveien	3	Metro-Rail/Tram	Combination	3	0º/45º/90º	6	2, 3	-----	10	8	None	Geographic Ref	Water	Frutiger	Fixed Angles	11	0º	8	SkinneAug06we	18.998 x 18.998	PDF	Adobe InDesi	86.61	-----
Europe	France	Paris	2.167.994	86	RATP	Bus	2007	www.ratp.fr	1	Bus	Combination	2	-----	-----	10	-----	7	14	Main Streets	Politic	Water	Parisine	0º	1,3	Free	4	bus_paris.pdf/B	38.595 x 38.195	PDF	Adobe Illustra	184.44	CC83855
Europe	France	Paris	2.167.994	86	RATP	Bus | T	2007	www.ratp.fr	2	Bus/Tram	French	1	-----	7	-----	Pictograms, 3d	13	15 or More	Street Map	Geographic Ref	Water & Land	Parisine	0º	3	Free	4	bus_paris_geo.	127.985 x 98.988	PDF	-----	2.4	CC83855
Europe	France	Paris	2.167.994	86	RATP	M | Rer | T	2006	www.ratp.fr	3	Metro-Rail/Bus/Tram	French	3	0º/45º/90º	8,9	2,3	-----	7	15 or More	None	Politic	Water	Parisine	0º	-----	-----	3	metro.pdf	40.000 x 40.000	PDF	-----	117.79	CC83855
Europe	Portugal	Porto	240.000	42	Metro	-----	2008	www.metrodop	1	Metro-Rail	French	2	-----	6	2	-----	N/A	5	None	Tariff & System	Water	DIN	0º	-----	-----	3	878918	85.362 x 114.287	PDF	-----	181.12	-----
Europe	Czech Republic	Prague	1.188.126	496	Metro a aut	-----	-----	www.dpp.cz	1	Bus	Combination	3	0º/45º/90º	9	4	-----	1	5	None	Geographic Ref	Water & Land	-----	0º	4	0º	8	BUS_prosinec_2	44.656 x 32.346	PDF	CorelDraw	2.48	DP-Praha
Europe	Czech Republic	Prague	1.188.126	496	Prazske inte	Metro a Tramva	2008	www.dpp.cz	1	Metro-Rail	Combination	2	-----	4,9	4	Pictograms	2	4	None	Geographic Ref	Water	-----	Fixed Angles	4	Free	9	metro_a_tram	43.477 x 31.178	PDF	Adobe Illustra	959.02	amos
Europe	Germany	Rhein-Ruhr	10.442	7826	VRR	Linienplan Schn	2007	www.vrr.de	1	Metro-Rail	Combination	3	0º/45º/90º	7	6	-----	N/A	5	None	Politic	None	Helvetica/ Cour	Fixed Angles	10	Fixed Angles	4	linienplan_schn	42.613 x 30.321	PDF	Adobe Illustra	341.32	helge hinniger
Europe	Germany	Rhein-Ruhr	10.442	7826	H-BAHN21	Linienplan Dortr	-----	www.vrr.de	2	Metro-Rail/Bus	French	1	-----	7	6	Illustration	13	15 or More	Street Map	Geographic Ref	Water & Land	Helvetica	0º	1	Free	1	Do_Internet_07	109.987 x 89.990	PDF	Adobe Illustra	1.260	Christian Hippler
South America	Brazil	Rio de Janeiro	6.094.183	1182	MetroRio	-----	2008	www.metrorio.(	1	Metro-Rail	French	2	-----	9	2	-----	N/A	4	None	Geographic Ref	Water	-----	0º	-----	-----	7	mapa_esquema	2481 x 3507	JPG	-----	2.100	-----
Europe	Italy	Roma	2.718.768	1285	Metroroma	RomaMetroPerM	-----	www.metrorom	1	Metro-Rail	French	3	0º/45º/90º	8	2	-----	N/A	7	None	Tariff & System	Water	Frutiger/Helveti	Fixed Angles	-----	-----	7	Piantina Met.Ro	20.812 x 20.811	PDF	Adobe Illustra	105.18	-----
Europe	Italy	Roma	2.718.768	1285	RomaCitta	-----	-----	www.metrorom	2	Metro-Rail/Bus	Classic	1	-----	7	-----	Pictograms	1,8	7	Street Map	Geographic Ref	Water & Land	-----	0º	4	Free	Other	mappa Roma (C	42.011 x 29.700	PDF	-----	9.460	-----
Europe	Austria	Salzburg	150.269	66	SalzburgAG	-----	-----	www.salzburg-a	1	Bus	Combination	3	0º/45º/90º	7	6	-----	1	9	None	Geographic Ref	Water & Land + North	Frutiger/ Transit	0º	10	Fixed Angles	4	Salzburg LNP_0	41.447 x 29.700	PDF	FreeHand 8.0.	315.38	-----
North America	USA	San Francisco	739.426	601	BART / SFM	-----	-----	www.bart.gov	1	Metro-Rail	French	2	-----	7	6	-----	N/A	5	None	Geographic Ref	Water & Land	-----	0º	-----	-----	4	N/A	500 x 500	JPG	-----	44	-----
North America	USA	San Francisco	739.426	601	SFMTA	-----	-----	www.sfmta.com	4	Metro-Rail/Tram/Bus/Fer	Combination	1	-----	4	-----	Pictograms	1	13	Main Streets	Geographic Ref	Water & Land	StoneSerif/ Univ	-----	7	Free	13	SFMTA Muni sys	63.493 x 54.604	PDF	-----	749.91	-----
South America	Chile	Santiago	5.428.590	641	Transantiag	Mapa de Recorri	2007	www.transantia	2	Metro-Rail/Bus	Combination	2	-----	9	2,11	Pictograms	9	15 or More	Street Map	Politic	Water & Land	TSInfo/ TSMapa	Fixed Angles	9,12	Free	7	mapa_general	67.992 x 88.010	PDF	FreeHand MX	807	Joel Gutierrez
South America	Brazil	Sao Paulo	10.927.985	1523	Metro / SPT	Rede Metropolit	2006	www.metro.sp.	1	Metro-Rail	French	3	0º/45º/90º	10	3,9	-----	N/A	11	None	Geographic Ref	Water + North	Arial MT	Fixed Angles	-----	-----	10	mapadebolsosit	29.697 x 20.998	PDF	CorelDraw	847.21	-----
Asia	Korea, South	Seoul	10.924.870	606	Metro	Metro lines in S	-----	www.seoulmetr	1	Metro-Rail	French	3	0º/30º/45º/90º	9	11	-----	N/A	11	None	Geographic Ref	Water & Land	-----	Fixed Angles	-----	-----	3	map_korea	1433 x 1012	JPG	-----	820	-----
Europe	Spain	Sevilla	699.759	141	TUSSAM	Red de Líneas	2007	www.tussam.es	1	Bus	Combination	1	-----	1	-----	3D	9	15 or More	Street Map	Geographic Ref	Water & Land + North	Gen.Helvetica/C	-----	11	Free	7	plano_TUSSAM	42.011 x 29.700	PDF	-----	7.220	GREGORIO
Asia	Singapore	Singapore	4.425.720	693	SMRT	BUKIT BATOK	2007	www.smrt.com	1	Metro-Rail	French	3	0º/45º/90º	9	-----	-----	6	15 or More	None	-----	None	Arial/BlissCaps/	0º	-----	-----	3	Butik_Batok_Se	41.976 x 29.665	PDF	-----	1.300	-----
Asia	Singapore	Singapore	4.425.720	693	-----	-----	-----	-----	1	Metro-Rail	French	3	0º/45º/90º	6	1,2	-----	N/A	4	None	-----	None	-----	0º	-----	-----	6	routemap	127.620 x 86.985	PDF	Adobe Photos	370.69	-----
Europe	Russia	St. Petersburg	4.577.751	606	-----	-----	-----	www.saint-pete	1	Metro-Rail	French	3	0º/90º	9	8	-----	N/A	4	None	Geographic Ref	Water	-----	0º	-----	-----	7	saint-petersburg	800 x 1000	JPG	-----	88	-----
Europe	Sweden	Stockholm	788.269	188	BusvHuBo	-----	-----	www.sl.se	1	Bus	French	3	0º/45º/90º	-----	1	-----	N/A	15 or More	None	Geographic Ref	Water + North	SLGothicTimeta	0º	-----	-----	7	vHuBo_karta	18.598 x 15.844	PDF	Adobe Illustra	98.65	-----
Europe	Sweden	Stockholm	788.269	188	SL Spartraf	-----	2007	-----	1	Metro-Rail	French	3	0º/45º/90º	2	3	-----	N/A	5	None	Tariff & System	None	SLGothic	Fixed Angles	-----	-----	2	SL_Spartrafik_2	77.791 x 57.593	PDF	Adobe Illustra	404.35	-----
Europe	Germany	Stuttgart	597.158	207	VVS	Verbund - Schie	2007	www.vvs.de	1	Metro-Rail	French	3	30º	2	12	Thematic Pictog	N/A	15 or More	None	-----	None	Helvetica/ Unive	0º	-----	-----	13	VSN 2008	42.011 x 29.700	PDF	FreeHand MX	80.68	Ingo Profuß
Europe	Germany	Stuttgart	597.158	207	S-Bahnen	Stadbahnen	2007	www.vvs.de	1	Metro-Rail	French	3	0º/45º/90º	2	12	Thematic Pictog	N/A	15 or More	None	-----	None	AgfaRotisSemis	0º	11	0º	13	lin_445x300	44.518 x 30.013	PDF	Adobe InDesi	526.42	-----
Europe	Germany	Stuttgart	597.158	207	-----	Verkehrslinienpl	2007	www.vvs.de	1	Bus	Classic	1	-----	4	-----	Thematic Pictog	N/A	3	Street Map	Geographic Ref	Water & Land	Helvetica	0º	4	Free	12	Atlas / MapServ	77.179 x 84.234	PDF	MapServer	3.430	Mentz Datenverarbeitu
Oceania	Australia	Sydney	4.254.900	12145	CityRail	-----	-----	www.cityrail.ns	1	Metro-Rail	French	3	0º/45º/90º	6	3	-----	N/A	12	None	-----	Water + North	Frutiger/Helveti	Fixed Angles	-----	-----	13	CityRail A3 map	29.697 x 41.995	PDF	QuarkXPress	674.25	-----
Asia	Taiwan	Taipei	2.630.872	272	Metro /Dep.	-----	-----	www.trtc.com.t	1	Metro-Rail	French	3	0º/45º/90º	9	3	-----	N/A	6	None	-----	None	-----	0º	-----	-----	8	N/A	986 x 1476	PDF	-----	220	-----
Asia	Taiwan	Taipei	2.630.872	272	Bus Routes	-----	-----	www.trtc.com.t	1	Bus	Classic	1	-----	-----	-----	Pictograms	N/A	15 or More	None	Geographic Ref	Water & Land + North	Arial	-----	11	0º	13	Tipei	61.493 x 84.490	PDF	Adobe Illustra	15.88	-----
Asia	Taiwan	Taipei	2.630.872	272	Downtown	-----	-----	www.trtc.com.t	1	Bus	Classic	2	-----	-----	-----	Pictograms	N/A	4	Street Map	Geographic Ref	Water & Land + North	-----	-----	11	0º	Other	downTown	84.990 x 61.993	PDF	Adobe Illustra	9.970	-----
Asia	Iran	Tehran	7.185.831	717	Metro	-----	-----	www.tehranme	1	Metro-Rail	French	1	-----	7,8	11	Illustration	N/A	10	Street Map	Geographic Ref	Water & Land	-----	0º			8	TehranMap-Met	84.657 x 66.202	PDF	-----	7.430	-----
Asia	Israel	Tel Aviv	390.100	51	-----	-----	-----	-----	1	Bus	French	1	-----	-----	1	Pictograms	11	15 or More	Main Streets	Geographic Ref	Water & Land	-----	-----	7	Free	-----	maps_5426	44.480 x 44.480	PDF	-----	12.220	-----
Asia	Japan	Tokio	12.790.000	2187	Metro	-----	-----	www.tokyomet	1	Metro-Rail	French	3	0º/30º/45º/90º	9	6	-----	N/A	15 or More	None	Geographic Ref	Water & Land	-----	Fixed Angles	-----	-----	7	network1	29.698 x 20.995	PDF	-----	1.350	-----
Asia	Japan	Tokio	12.790.000	2187	Metro	-----	2007	www.tokyomet	1	Metro-Rail	French	3	0º/30º/45º/90º	9	7	-----	N/A	15 or More	None	Geographic Ref	Water & Land	-----	Fixed Angles	-----	-----	7	network2	29.698 x 20.996	PDF	-----	913.84	-----
Europe	Italy	Torino	905.209	130	GTT	-----	-----	www.comune.t	1	Bus	French	1	-----	-----	-----	Pictograms	1,13	15 or More	Street Map	Geographic Ref	Water & Land	Gen.Swis721	-----	7	0º	7	GTT_2007_mes	97.069 x 137.563	PDF	-----	11.21	u997
North America	Canada	Toronto	2.503.281	630	TTC	-----	-----	www.toronto.ca	2	Metro-Rail/Bus	Classic	1	-----	9	2	Generic Point	9,13	6	Main Streets	Geographic Ref	None	Arial/Gen.86/He	0º	Other	0º	-----	TTC Rideguide 2	69.207 X 50.159	PDF	Adobe InDesi	969.15	Ian Dunlop
Europe	France	Toulouse	426.700	35	Tisseo	-----	-----	www.tisseo.fr	1	Metro-Rail/Bus/Tram	French	1	-----	10	3	Pictograms	13	15 or More	Highways & Ave	Geographic Ref	Water & Land	-----	0º	2,11	Free	7	731932	105.821 x 105.821	PDF	-----	1.790	-----
Europe	Spain	Valencia	807.200	135	MetroValen	Plano Zonal	-----	-----	1	Metro-Rail	French	3	0º/45º/90º	6	2	-----	N/A	5	None	Tariff & System	None	-----	Fixed Angles	-----	-----	6	zonal	29.700 x 42.011	PDF	-----	488.54	-----
Europe	Spain	Valencia	807.200	135	MetroValen	Plano de la xarx	-----	-----	1	Metro-Rail	French	2	-----	6	2	Pictograms	N/A	6	None	Geographic Ref	Water & Land	-----	0º	-----	-----	6	redmetro	29.700 x 42.011	PDF	-----	939.36	-----
North America	Canada	Vancouver	611.869	115	TransLink	-----	-----	-----	3	Metro-Rail/Bus/Boat	Combination	1	-----	9	1	Pictograms	1	5	Highways & Ave	Geographic Ref	Water & Land	Frutiger	0º	4	Free	7	Web-Regional_R	32.133 x 24.155	PDF	FreeHand MX	1.590	Lester Jones
Europe	Italy	Venezia	268.934	412	Actv	Hellovenezia	-----	www.actv.it	1	Boat	French	3	0º/45º/90º	Other	3	Illustration	Other	15 or More	None	Geographic Ref	Land	-----	Fixed Angles	7	Fixed Angles	7	mappa_linee_2	29.697 x 20.998	PDF	-----	436.21	mpasqualotto
Europe	Austria	Vienna	1.670.347	415	Wienerlinie	-----	-----	www.wienerlini	1	Metro-Rail	French	3	0º/45º/90º	5	3	-----	N/A	6	None	Geographic Ref	Water	Courier/ Helveti	Fixed Angles	-----	-----	6	svp_7	29.697 x 20.998	PDF	-----	448.27	-----
North America	USA	Washington D.C.	582.049	177	Metro (WMA	System Map	2006	-----	1	Metro-Rail	French	3	0º/45º/90º	10	4	Illustration	N/A	5	Highways & Ave	Geographic Ref	Water & Land + North	Helvetica	Fixed Angles	-----	-----	13	colormap_letter	21.587 x 27.937	PDF	-----	471.51	-----
North America	USA	Washington D.C.	582.049	177	Metro (WMA	System Map	2006	-----	1	Metro-Rail	Classic	2	-----	-----	-----	Generic Point/ i	8	7	Main Streets	Geographic Ref	Water & Land	Helvetica	-----	3	0º	8	colormap_letter	21.587 x 27.937	PDF	-----	471.51	-----
Europe	Switzerland	Zurich	376.815	92	ZVV	Stadt Zurich	2008	www.zvv.ch	3	Metro-Rail/Bus/Boat	Combination	3	0º/45º/90º	10	2	-----	8	11	None	Geographic Ref	Water	Meta	Fixed Angles	10	Fixed Angles	Other	Verkehrsbetrieb	29.697 x 41.497	PDF	FreeHand MX	228.56	H+A Eggman
Europe	Switzerland	Zurich	376.815	92	ZVV	-----	2007	www.zvv.ch		Metro-Rail	French	3	0º/45º/90º	9	2	Pictograms	N/A	12	None	Politic	Water	Meta	Fixed Angles	3,11	0º	13	SBahn_A6_D.g	10.499 x 14,798	PDF	QuarkXPress	49.56	Rahel Gasper

STRUCTURAL LEVEL

• Style

11,9%	Classic Style
62,7%	French Style
25,4%	Combination

• Fidelity / Abstratcness

29,9%	Scale or base in a topographic maps without much distortion.
17,9%	Based on topographic map but distorting crowded areas (i.e. downtown) and simplifying certain features (i.e. straighten lines).
52,2%	Schematic Map with streight lines and fixed angles: 0°, 30°, 45°, 60° or 90°.

• Fixed Angles

0,0%	0°
0,0%	0°/30°
7,5%	0°/30°/45°/90°
0,0%	0°/30°/90°
0,0%	0°/45°
40,3%	0°/45°/90°
2,2%	0°/90°
0,7%	20°/90°
0,7%	45°
0,7%	Other
47,8%	N/A

GRAPHIC LEVEL

Point Symbols

• Stop/Station (numbers correspond with the symbols presented in Annex 1)

2,2%	1
0,0%	2
0,0%	3
3,0%	4
0,7%	4 & 9
1,5%	5
13,4%	6
0,7%	6 & 13
6,7%	7
0,7%	7 & 8
1,5%	8
0,7%	8 & 9
26,1%	9
17,2%	10
2,2%	11
3,0%	12
2,2%	13
11,9%	N/A
1,5%	10 & N/A
0,7%	5 & 9
0,7%	9 & N/A
0,7%	9 & 10
0,7%	N/A, 9 for trains
Other	1,5%

• Landmarks

0,7%	3D: Tridimentional Illustration.
7,5%	Generic Point: A point symbol use to demark the location of different landmarks.
0,7%	Generic Point/ illustration.
8,2%	Illustration
2,2%	Illustration/ Thematic pictogram
23,1%	Pictograms
0,7%	Pictograms, 3d
4,5%	Thematic Pictograms: Unique and sintetic representation of a particul ar landmark (ex. Eifel tower)
52,2%	N/A

Line Symbols

• Directionality (numbers correspond with the symbols presented in Annex 1)

8,2%	1
0,7%	1 &14
0,7%	1 & 8
3,0%	2
0,7%	3
3,7%	4
1,5%	5
1,5%	6
2,2%	7
4,5%	8
3,0%	9
0,7%	9 & 14
3,0%	10
0,7%	11
3,0%	12
0,0%	13
6,0%	14
0,7%	-
0,7%	3 & 4
53,0%	N/A
2,2%	Other

• N° Line's Colors

0,0%	1
2,2%	2
6,0%	3
9,0%	4
10,4%	5
8,2%	6
6,7%	7
4,5%	8
5,2%	9
5,2%	10
6,7%	11
3,7%	12
2,2%	13
3,7%	14
26,1%	15 & more

• Streets/Ave.

11,9%	Highways & Avenues
16,4%	Main Streets
56,7%	None
14,9%	Street Map

Area Symbols

• Background Area

1,5%	Arbitrary
61,9%	Geographic References
7,5%	Politic
16,4%	Tariff & System Zones
12,7%	N/A

• Geographic References

0,7%	Compass (North)
1,5%	Land
1,5%	Land + North
20,1%	None
3,0%	North
23,1%	Water
30,6%	Water & Land
16,4%	Water & Land + North
3,0%	Water + North

TYPOGRAPHIC LEVEL

Labelling

• Station Orientation

50,0%	0°
0,0%	Curve
32,1%	Fixed Angles
1,5%	Free
16,4%	–––––

• Route Labelling (numbers correspond with the symbols presented in Annex 1)

1,5%	1
0,0%	2
0,7%	2 & 12
8,2%	3
0,7%	3 & 12
0,7%	3 & 13
16,4%	4
0,7%	4 & 2
0,7%	4 & 6
1,5%	5
1,5%	6
7,5%	7
1,5%	8
0,0%	9
0,7%	9 & 13
4,5%	10
0,0%	11
6,7%	12
0,7%	13
44,0%	–––––
0,7%	1 & 3
0,7%	Other

Route Orientation

27,6%	0°
9,0%	Fixed Angles
18,7%	Free
3,0%	Free Curve
41,8%	–––––

• Terminus

0,7%	1
9,0%	2
0,7%	2 & 11
7,5%	3
7,5%	4
0,7%	5
6,7%	6
22,4%	7
8,2%	8
0,0%	9
8,2%	10
0,7%	11
0,0%	12
1,5%	13
6,0%	14
1,5%	15
7,5%	–––––
11,2%	Other

Annex 3

International Survey of Public Transport Maps

Amsterdam | Metro Amsterdam* Netherlands

CITY

Population:
1.468.122
Area (km2) :
219

MAP

Institution:
GVS
System:
Lijnennetkaart / Metro Amsterdam
Year:
2008
Source:
www.gvb.nl
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
Studio Mijksenaar

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 4 colors	**Fonts:** Courier/LinotypeEuroFontA-toF/Univers	**Route Orientation:** ——
Fidelity/Abstratcness: Simplified	**Interchange:** Rings Stressed	**Streets/Ave.:** ——	**Station Orientation:**	**Terminus:**
Fixed Angles: ——	**Landmarks:** ——	**Background Area:** Geographic References	**Route Labelling:** ——	
	Directionality:	**Geographic References:** Water & Land		

Amsterdam | Lijnennetkaart Netherlands

CITY

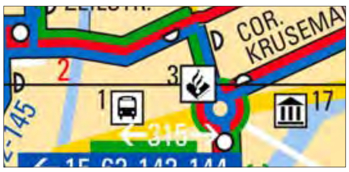
Population:
1.468.122
Area (km2) :
219

MAP

Institution:
GVS
System:
Lijnennetkaart/
Year:
2008
Source:
www.gvb.nl
Modes Number:
4
Modes:
Metro-Rail/Tram/Bus/Ferry

DOC. PROPERTIES

Format (cm):
69.128 x 50.080
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 4 colors	**Fonts:** Courier/Univers	**Route Orientation:** Free
Fidelity/Abstratcness: Cartographic	**Interchange:** Pictogram,Concentric Rings	**Streets/Ave.:** Highways & Avenues	**Station Orientation:** 0º	**Terminus:** 23
Fixed Angles: ——	**Landmarks:** Pictograms	**Background Area:** Geographic References	**Route Labelling:** 23	
	Directionality: 23	**Geographic References:** Water & Land		

Athens |

CITY

Population:
3.761.810
Area (km2) :
411

MAP

Institution:
OASA (Athens Urban Transport Organization)
System:
——
Year:
——
Source:
www.oasa.gr
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
299,965 x 299,965
Software:
CorelDraw
Designer/Author:
Charich

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Concentric Rings
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
7 colors
Streets/Ave.:
Highways & Avenues
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Antique Olive/Helvetica/ Rockwell
Station Orientation:
——
Route Labelling:
23

Route Orientation:
0º
Terminus:
Other

Athens | Athens Metro development map

CITY

Population:
3.761.810
Area (km2) :
411

MAP

Institution:
ATTIKO METRO
System:
Athens Metro development map
Year:
——
Source:
www.ametro.gr/page/
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
42,011 x 29,700
Software:
Acrobat Distiller 7.0.5
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Other
Landmarks:
——
Directionality:
——

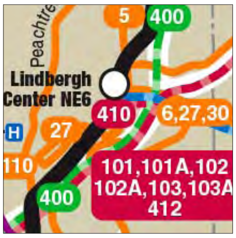
Nº Line's Colors:
6 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
Free Curve
Terminus:

Atlanta | Metropolitan Atlanta Regional Transit Map (2) USA



CITY

Population:
486.411
Area (km2) :
343

MAP

Institution:
MARTA (Metropolitan Ayalnta Rapid Transit Authority)
System:
Metropolitan Atlanta Regional Transit Map
Year:
2007
Source:
www.itsmarta.com/
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
93.969 x 60.318
Software:
FreeHand 10
Designer/Author:
——

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Combination	**Stop/Station:**	**Nº Line's Colors:** 9 colors	**Fonts:** Frutiger/Helvetica/Myriad	**Route Orientation:** 0º
Fidelity/Abstractness: Cartographic	**Interchange:** ——	**Streets/Ave.:** Highways & Avenues	**Station Orientation:** 0º	**Terminus:** ——
Fixed Angles: ——	**Landmarks:** Generic Point	**Background Area:** Geographic References	**Route Labelling:**	
	Directionality:	**Geographic References:** Water & Land + North		

Atlanta | Metropolitan Atlanta Regional Transit Map USA

CITY

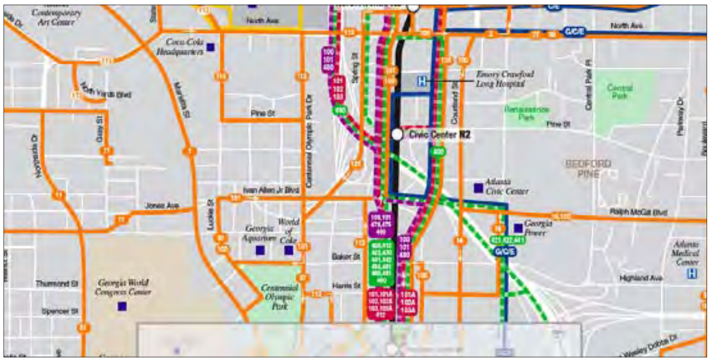
Population:
486.411
Area (km2) :
343

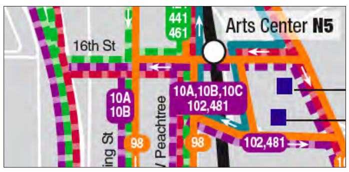
MAP

Institution:
MARTA (Metropolitan Ayalnta Rapid Transit Authority)
System:
Metropolitan Atlanta Regional Transit Map
Year:
2007
Source:
www.itsmarta.com/
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
93.969 x 60.318
Software:
FreeHand 10
Designer/Author:
——





DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Combination	**Stop/Station:**	**Nº Line's Colors:** 9 colors	**Fonts:** Frutiger/Helvetica/Myriad	**Route Orientation:** 0º
Fidelity/Abstractness: Simplified	**Interchange:** Ring	**Streets/Ave.:** Main Streets	**Station Orientation:** 0º	**Terminus:** ——
Fixed Angles: ——	**Landmarks:** Generic Point	**Background Area:** Geographic References	**Route Labelling:**	
	Directionality:	**Geographic References:** Water & Land		

Barcelona | Integrated Railway Network — Spain

Larger Exchange Point: Catalunya (11)

CITY

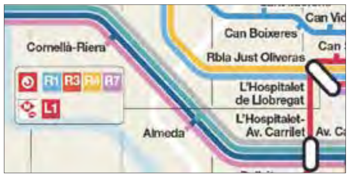
Population:
1.605.602
Area (km2) :
100

MAP

Institution:
TMB (Transports Metropolitans de Barcelona)
System:
Integrated Railway Network
Year:
2007
Source:
www.tmb.net
Modes Number:
4
Modes:
Metro-Rail/Funicular/Teleferic

DOC. PROPERTIES

Format (cm):
41.116 x 29.605
Software:
—
Designer/Author:
—



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/30º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
Pictograms
Directionality:

—
Nº Line's Colors:
15 or More
Streets/Ave.:
—
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
Helvetica
Station Orientation:
0º
Route Labelling:
—

Route Orientation:
—
Terminus:

Barcelona | Urban bus of Barcelona — Spain

CITY

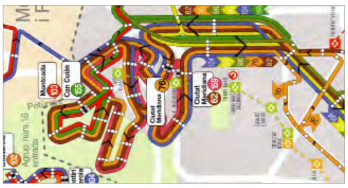
Population:
1.605.602
Area (km2) :
100

MAP

Institution:
TMB (Transports Metropolitans de Barcelona)
System:
Urban bus of Barcelona
Year:
—
Source:
www.tmb.net
Modes Number: 4
Modes:
Metro-Rail/Bus/Funicular/Teleferic

DOC. PROPERTIES

Format (cm):
—
Software:
—
Designer/Author:
—



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/30º/45º/90º

Graphic Level

Stop/Station:
—
Interchange:
—
Landmarks:
Illustration
Directionality:
—

Nº Line's Colors:
15 or More
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
—
Station Orientation:
—
Route Labelling:

Route Orientation:
Fixed Angles
Terminus:

Basel | Liniennetz

Switzerland

CITY

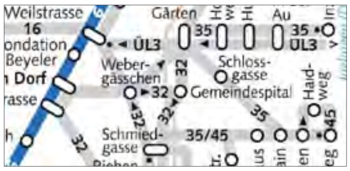
Population:
165.529
Area (km2) :
23

MAP

Institution:
BVB
System:
Liniennetz Basel und Umgebung
Year:
2006
Source:
www.bvb-basel.ch
Modes Number:
2
Modes:
Bus/Tram

DOC. PROPERTIES

Format (cm):
20.998 x 29.697
Software:
Illustrator CS2
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/30º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
Thematic Pictograms
Directionality:

Nº Line's Colors:
10 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
Fixed Angles
Terminus:

Berlin | S/U Netz

Germany

CITY

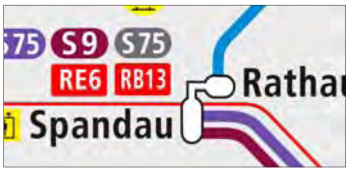
Population:
3.410.000
Area (km2) :
892

MAP

Institution:
BVG
System:
S/U Netz
Year:
2007
Source:
www.bvg.de
Modes Number:
2
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
41.976 x 29.700
Software:
FreeHand 9
Designer/Author:
BVG



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
——
Directionality:
——

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
——

Typographic Level

Fonts:
GenBVG/GenTransit
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:
Other

Berlin | TramMetro

Germany

CITY

Population:
3.410.000
Area (km2) :
892

MAP

Institution:
BVG
System:
M/Tram Netz
Year:
2007
Source:
www.bvg.de
Modes Number:
2
Modes:
Metro-Rail/Tram

DOC. PROPERTIES

Format (cm):
41.976 x 29.700
Software:
FreeHand 9
Designer/Author:
BVG

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
——
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
——

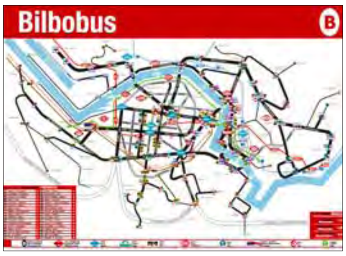
Typographic Level

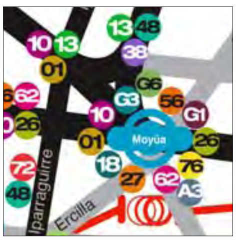
Fonts:
GenBVG/GenTransit
Station Orientation:
Fixed Angles
Route Labelling:

Route Orientation:
Fixed Angles
Terminus:
Other

Bilbao | Bilbobus

Spain





CITY

Population:
354.145
Area (km2) :
41

MAP

Institution:
Metro Bilbao
System:
Bilbobus
Year:
2007
Source:
www.metrobilbao.net
Modes Number:
1
Modes:
Metro-Rail/Tram/Bus

DOC. PROPERTIES

Format (cm):
75.838 x 114.251
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:
——
Interchange:
Pictogram
Landmarks:
——
Directionality:
——

Nº Line's Colors:
15 or More
Streets/Ave.:
Highways & Avenues
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Helvetica
Station Orientation:
——
Route Labelling:

Route Orientation:
0º
Terminus:
Other

Bogotá| Transmilenio   Colombia

CITY

City:
Bogota
Population:
7.033.914
Area (km2) :
1587

MAP

Institution:
Transmilenio
System:
——

Year:
——

Source:
www.transmilenio.gov.co
Modes Number: 1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
——

Software:
——

Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
Illustration
Directionality:
——

Nº Line's Colors:
9 colors
Streets/Ave.:
Highways & Avenues
Background Area:
Geographic References
Geographic References:
Land + North

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:
23
23

Boston| System Map; Official Public Transit   USA

CITY

Population:
590.763
Area (km2) :
232

MAP

Institution:
MBTA (Massachusetts Bay Transportation Authority)
System:
System Map; Official Public Transit
Year:
2006
Source:
www.mbta.com
Modes Number:
3
Modes:
Metro-Rail/Bus/Boat

DOC. PROPERTIES

Format (cm):
——

Software:
——

Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:
Other
Interchange:
Pictogram
Landmarks:
Illustration
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
Helvetica/Palatino/Times
Station Orientation:
——
Route Labelling:

Route Orientation:
0º
Terminus:

Boston| Rapid Transit and Commuter Rail System * USA

CITY

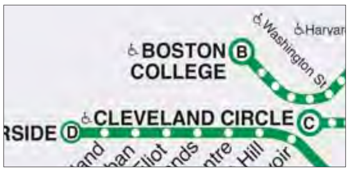
Population:
590.763
Area (km2) :
232

MAP

Institution:
MBTA (Massachusetts Bay Transportation Authority)
System:
Rapid Transit and Commuter Rail System
Year:
2006
Source:
www.mbta.com
Modes Number: 3
Modes:
Metro-Rail/Boat

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
——
Directionality:
——

Nº Line's Colors:
7 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Helvetica/Palatino/Times
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Brasilia| Metro System Brazil

CITY

Population:
2.455.903
Area (km2) :
5802

MAP

Institution:
N/A
System:
——
Year:
——
Source:
www.metro.df.gov.br
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
——
Directionality:
——

Nº Line's Colors:
2 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:
——

Brussels| System Map

Belgium

CITY

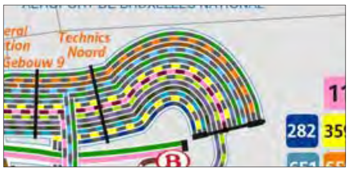
Population:
1.100.000
Area (km2) :
242

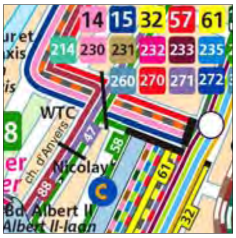
MAP

Institution:
STIB/MIVB
System:
N/A (Network)
Year:
2008
Source:
www.stib.be
Modes Number:
3
Modes:
Metro-Rail/Bus/Tram

DOC. PROPERTIES

Format (cm):
49.994 x 49.994
Software:
Adobe Illustrator CS2
Designer/Author:
—





DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
—

Graphic Level

Stop/Station:
Interchange:
Rings Connected
Landmarks:
Pictograms
Directionality:
Other

Nº Line's Colors:
15 or More
Streets/Ave.:
Street Map
Background Area:
Arbitrary
Geographic References:
Water & Land + North

Typographic Level

Fonts:
Brusseline/Futura/Helvetica/Times/
Station Orientation:
0º
Route Labelling:

Route Orientation:
Free
Terminus:

Brussels| Metro System

Belgium

CITY

Population:
1.100.000
Area (km2) :
242

MAP

Institution:
STIB/MIVB
System:
N/A (Metro)
Year:
2007
Source:
www.stib.be
Modes Number:
2
Modes:
Metro-Rail/Tram

DOC. PROPERTIES

Format (cm):
59.993 x 39.995
Software:
Adobe Illustrator CS3
Designer/Author:
—

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:
Interchange:
Ring
Landmarks:
—
Directionality:
—

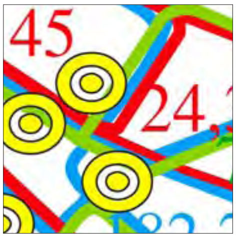
Nº Line's Colors:
9 colors
Streets/Ave.:
—
Background Area:
—
Geographic References:
—

Typographic Level

Fonts:
—
Station Orientation:
Fixed Angles
Route Labelling:
—

Route Orientation:
—
Terminus:

Bucharest | Reteau de Transport in Comun 2007 — Romania

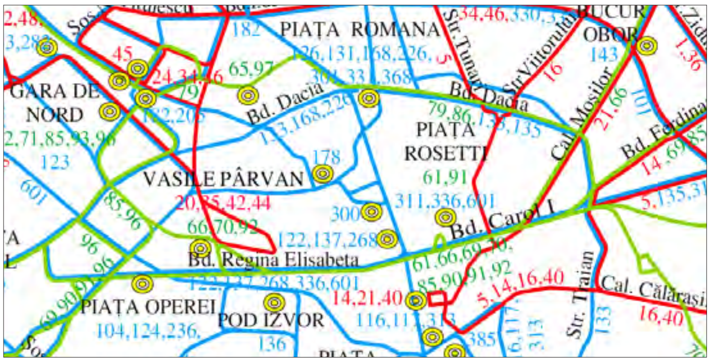


CITY

Population:
2.082.000
Area (km2) :
226

MAP

Institution:
RATB
System:
Reteaua de Transport In Comun
Year:
2007
Source:
www.ratb.ro
Modes Number:
3
Modes:
Bus/Tram/Troley



DOC. PROPERTIES

Format (cm):
42,011 x 29,700
Software:
PScript5.dll
Designer/Author:
E_Dumitrescu

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Classic	**Stop/Station:** ——	**Nº Line's Colors:** 3 colors	**Fonts:** Times New Roman/Toronto	**Route Orientation:** Free Curve
Fidelity/Abstratcness: Simplified	**Interchange:** ——	**Streets/Ave.:** Main Streets	**Station Orientation:** ——	**Terminus:** Other
Fixed Angles: ——	**Landmarks:** Pictograms	**Background Area:** ——	**Route Labelling:**	
	Directionality: ——	**Geographic References:** ——		

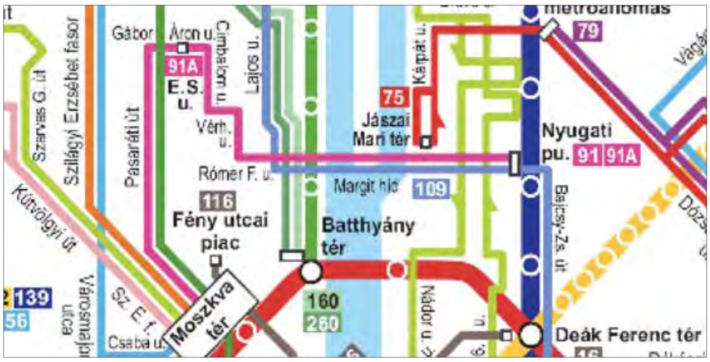
Budapest | Reteau de Transport in Comun 2007 — Hungary

CITY

Population:
1.696.128
Area (km2) :
525

MAP

Institution:
BKV
System:
Reteau de Transport in Comun 2007
Year:
2007
Source:
www.bkv.hu
Modes Number:
2
Modes:
Bus/Tram



DOC. PROPERTIES

Format (cm):
——
Software:
Adobe Indesign CS3 (5.0)
Designer/Author:
dtp

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 15 or More	**Fonts:** Arial MT/Arial Narrow/Helvetica	**Route Orientation:** Fixed Angles
Fidelity/Abstratcness: Schematic	**Interchange:** 1,Iregular Polygon	**Streets/Ave.:** ——	**Station Orientation:** Fixed Angles	**Terminus:** Other
Fixed Angles: 0º/45º/90º	**Landmarks:** ——	**Background Area:** ——	**Route Labelling:**	
	Directionality:	**Geographic References:** Water		

Buenos Aires| Subte (P) — Argentina

CITY

Population:
3.034.161
Area (km2) :
203

MAP

Institution:
Subte / Metrovias
System:
——
Year:
——
Source:
www.subte.com.ar
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
39.683 x 22.222
Software:
Adobe Illustrator CS3
Designer/Author:
——

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 7 colors	**Fonts:** Frutiger	**Route Orientation:** ——
Fidelity/Abstractness: Schematic	**Interchange:** Rings Connected	**Streets/Ave.:** Highways & Avenues	**Station Orientation:** Fixed Angles	**Terminus:**
Fixed Angles: 0º/45º/90º	**Landmarks:** ——	**Background Area:** ——	**Route Labelling:** ——	
	Directionality: ——	**Geographic References:** ——		

Caracas| Rutas del Sistema Metro-Metrobus — Venezuela

CITY

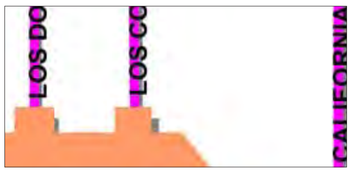
Population:
2.762.759
Area (km2) :
1930

MAP

Institution:
Metro
System:
Rutas del Sistema Metro-Metrobus
Year:
2007
Source:
www.metrodecaracas.com.ve
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
27.478 x 19.118
Software:
——
Designer/Author:
Gdiaz



DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 4 colors	**Fonts:** Arial/TimesNewRoman	**Route Orientation:** ——
Fidelity/Abstractness: Schematic	**Interchange:** Concentric Rings	**Streets/Ave.:** ——	**Station Orientation:** Fixed Angles	**Terminus:**
Fixed Angles: 0º/45º/90º	**Landmarks:** ——	**Background Area:** ——	**Route Labelling:** ——	
	Directionality: ——	**Geographic References:** ——		

Chicago| System map

USA

CITY

Population:
2.833.321
Area (km2) :
606

MAP

Institution:
CTA (Chicago Transit Authority)
System:
System Map
Year:
2009
Source:
www.transitchicago.com
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

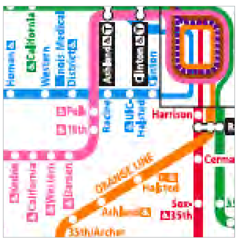
Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Combination **Fidelity/Abstractness:** Cartographic **Fixed Angles:** ——	**Stop/Station:** **Interchange:** Rings Connected **Landmarks:** Generic Point **Directionality:**	**Nº Line's Colors:** 13 colors **Streets/Ave.:** Highways & Avenues **Background Area:** Geographic References **Geographic References:** Water & Land + North	**Fonts:** Frutiger/Helvetica **Station Orientation:** 0º **Route Labelling:**	**Route Orientation:** 0º **Terminus:**

Chicago| Rail System

USA



CITY

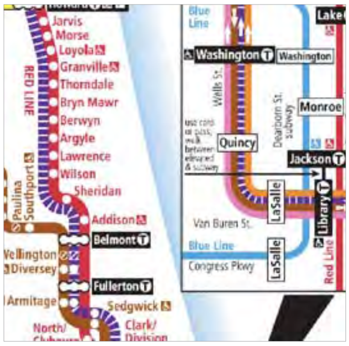
Population:
2.833.321
Area (km2) :
606

MAP

Institution:
CTA (Chicago Transit Authority)
System:
Rail System (The 'L')
Year:
2009
Source:
www.transitchicago.com
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French **Fidelity/Abstractness:** Schematic **Fixed Angles:** 0º/30º/45º/90º	**Stop/Station:** **Interchange:** Rings Connected **Landmarks:** —— **Directionality:** ——	**Nº Line's Colors:** 9 colors **Streets/Ave.:** —— **Background Area:** Geographic References **Geographic References:** Water + North	**Fonts:** Frutiger/Helvetica **Station Orientation:** Fixed Angles **Route Labelling:** 23	**Route Orientation:** Fixed Angles **Terminus:**

Cleveland| RTA System Map

USA

CITY

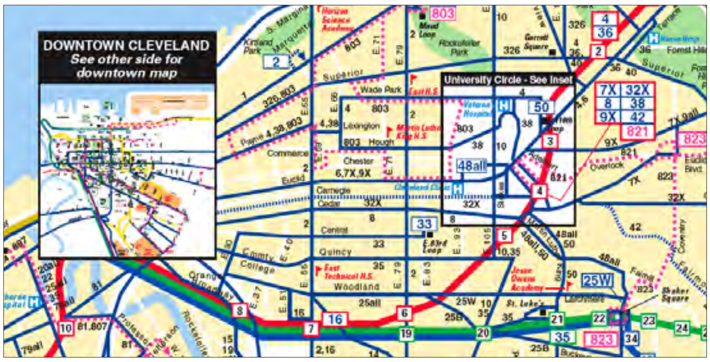
Population:
444.313
Area (km2) :
213

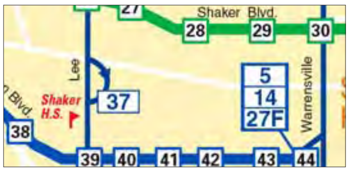
MAP

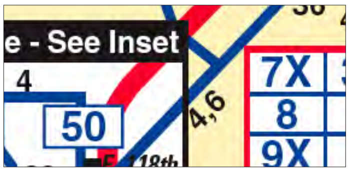
Institution:
RTA (Greater Cleveland Regional Transit Authority)
System:
RTA System Map
Year:
2007
Source:
www.gcrta.org
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
66.667 x 60.953
Software:
FreeHand MX
Designer/Author:
David Clawson







DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
———

Graphic Level

Stop/Station:
———
Interchange:
———
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
5 colors
Streets/Ave.:
Highways & Avenues
Background Area:
Geographic References
Geographic References:
Water & Land + North

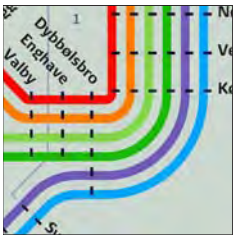
Typographic Level

Fonts:
Arial/Helvetica/Officina/Univers
Station Orientation:
———
Route Labelling:

Route Orientation:
Free
Terminus:
———

Copenhagen| DSB (P)

Denmark



CITY

Population:
1.145.804
Area (km2) :
88

MAP

Institution:
DSB
System:
———
Year:
———
Source:
www.dsb.dk
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
20.498 x 20.998
Software:
Adobe Indesign CS3 (5.0)
Designer/Author:
———

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
String
Landmarks:
———
Directionality:
———

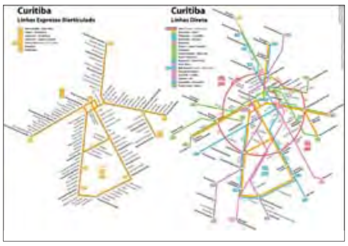
Nº Line's Colors:
7 colors
Streets/Ave.:
———
Background Area:
Tariff & System Zones
Geographic References:
———

Typographic Level

Fonts:
Times/ViaOffice/ViaSymbol
Station Orientation:
Fixed Angles
Route Labelling:

Route Orientation:
Fixed Angles
Terminus:

Curitiba| System — Brazil



CITY

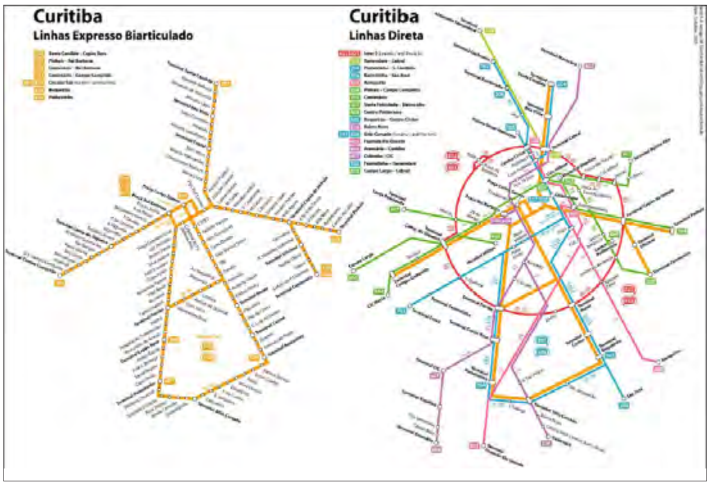
Population:
1.788.559
Area (km2) :
434967

MAP

Institution:
URBS (Urbanizacão de Curitiba)
System:
——
Year:
——
Source:
www.urbs.curitiba.pr.gov.br
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Schematic
Fixed Angles:
Other

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
——
Directionality:
23

Nº Line's Colors:
6 colors
Streets/Ave.:
——
Background Area:
——
Geographic References:
——

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:
23

Route Orientation:
0º
Terminus:

Delhi| Metro Rail — India

CITY

Population:
13.782.976
Area (km2) :
1483

MAP

Institution:
Metro Rail
System:
——
Year:
——
Source:
www.delhimetrorail.com
Modes Number:

MODES:
Metro-Rail

Doc. Properties

Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
——
Directionality:
——

Nº Line's Colors:
3 colors
Streets/Ave.:
Street Map
Background Area:
Politic
Geographic References:
Water & Land

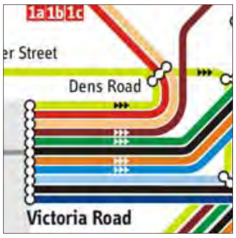
Typographic Level

Fonts:
——
Station Orientation:
Free
Route Labelling:
——

Route Orientation:
——
Terminus:
Other

Dundee| Bus Services in Dundee

UK



CITY

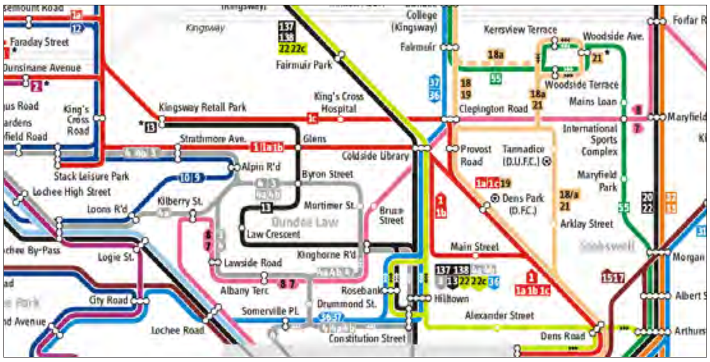
Population:
143.090
Area (km2) :
67

MAP

Institution:
Dundeetravelinfo
System:
Bus Services in Dundee
Year:
2005
Source:
www.dundeetravelinfo.com
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
52.309 x 24.772
Software:
CorelDRAW Version 12.0
Designer/Author:
SDG



DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

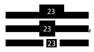
Stop/Station:

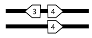
Interchange:
Rings Connected
Landmarks:
Generic Point
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Highways & Avenues
Background Area:
Geographic References
Geographic References:
Water

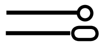
Typographic Level

Fonts:
Frutiger/InfoDisp/Meta
Station Orientation:
0º
Route Labelling:



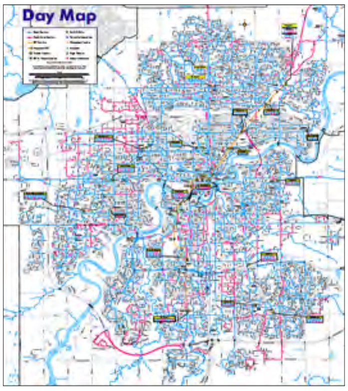


Route Orientation:
0º
Terminus:



Edmonton| Day Map

Canada



CITY

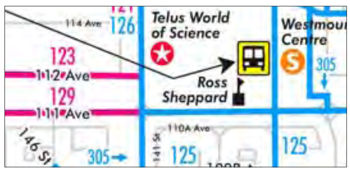
Population:
730.372
Area (km2) :
264

MAP

Institution:
ETS
System:
Day Map
Year:
2008
Source:
www.edmonton.ca
Modes Number:
2
Modes:
Metro-Rail/Tram/Bus

DOC. PROPERTIES

Format (cm):
59.401 x 65.926
Software:
Illustrator CS2
Designer/Author:
———



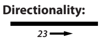
DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Cartographic
Fixed Angles:
———

Graphic Level

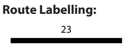
Stop/Station:
———
Interchange:
———
Landmarks:
Pictograms
Directionality:



Nº Line's Colors:
3 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water + North

Typographic Level

Fonts:
Arial/FuturaBT
Station Orientation:
0º
Route Labelling:



Route Orientation:
Free
Terminus:
———

Florence| System Map Italy

CITY

Population:
366.488
Area (km2) :
39

Map
Institution:
ATAF
System:
——

Year:
2007
Source:
www.ataf.net
Modes Number:
1
Modes:
Bus

Doc. Properties
Format (cm):
29.700 x 20.988
Software:
Illustrator CS2
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/30º/45º/90º

Graphic Level

Stop/Station:
——
Interchange:
——
Landmarks:
Illustration
Directionality:

Nº Line's Colors:
8 colors
Streets/Ave.:
Highways & Avenues
Background Area:
Tariff & System Zones
Geographic References:
Water

Typographic Level

Fonts:
Clarendon/HelveticaRounded/Helvetica
Station Orientation:
0º
Route Labelling:

Route Orientation:
0º
Terminus:

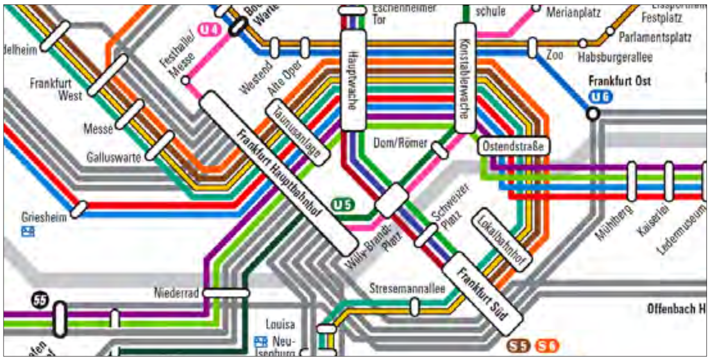
Frankfurt| Schnellbahnplan; Rhein-Main-Verkehrsverbund Germany

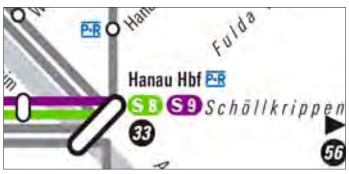
CITY

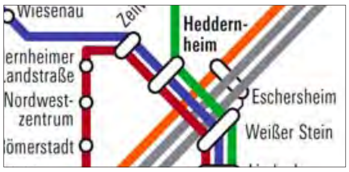
Population:
5.800.000
Area (km2) :
248

MAP
Institution:
RMV / VGF
System:
Schnellbahnplan; Rhein-Main-Verkehrsverbund
Year:
2007
Source:
www.rmv.de
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES
Format (cm):
59.393 x 41.995
Software:
FreeHand MX
Designer/Author:
Rhein-Main-Verkehrsverbund







DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
——
Directionality:
——

Nº Line's Colors:
15 or More
Streets/Ave.:
Highways & Avenues
Background Area:
——
Geographic References:
——

Typographic Level

Fonts:
LinotypeUnivers
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Frankfurt| TraffiQ; Liniennetzplan Frankfurt am Main

Germany

CITY

Population:
5.800.000
Area (km2) :
248

MAP

Institution:
RMV / VGF
System:
TraffiQ; Liniennetzplan Frankfurt am Main
Year:
2008
Source:
www.rmv.de
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
41.995 x 29.697
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Blank Space
Landmarks:
Pictograms
Directionality:
——

Nº Line's Colors:
10 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
Water

Typographic Level

Fonts:
HelveticaNeue
Station Orientation:
Fixed Angles
Route Labelling:
23

Route Orientation:
Free
Terminus:
23
23
23

Geneva| System Map

Switzerland

CITY

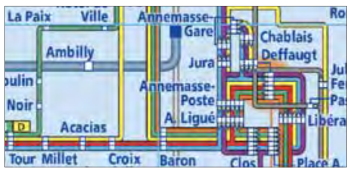
Population:
185.726
Area (km2) :
13

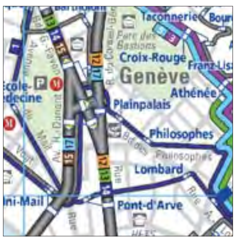
MAP

Institution:
TPG Transports Publics Genevois
System:
——
Year:
2007
Source:
www.tpg.ch
Modes Number:
3
Modes:
Metro-Rail/Bus/Boat

DOC. PROPERTIES

Format (cm):
67.935 x 59.008
Software:
Illustrator CS2
Designer/Author:
——





DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Other
Landmarks:
Pictograms
Directionality:
23

Nº Line's Colors:
15 or More
Streets/Ave.:
Main Streets
Background Area:
Tariff & System Zones
Geographic References:
Water + North

Typographic Level

Fonts:
Frutiger/ Universe
Station Orientation:
0º
Route Labelling:
23
23
23

Route Orientation:
Free
Terminus:

Genova| Mappa dei Trasporti Pubblici — Italy

CITY

Population:
615.686
Area (km2) :
243

MAP

Institution:
AMT
System:
Mappa dei Trasporti Pubblici
Year:
2006
Source:
www.amt.genova.it
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
75.768 x 65.997
Software:
—
Designer/Author:
—

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
—

Graphic Level

Stop/Station:
—
Interchange:
—
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
8 colors
Streets/Ave.:
Main Streets
Background Area:
Politic
Geographic References:
Water & Land

Typographic Level

Fonts:
—
Station Orientation:
—
Route Labelling:

Route Orientation:
Free
Terminus:

Glasgow| Local Rail Services in the SPT Area — UK

CITY

Population:
1.750.000
Area (km2) :
176

MAP

Institution:
SPT
System:
Local rail services in the SPT area
Year:
2007
Source:
www.spt.co.uk
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.697 x 20.998
Software:
—
Designer/Author:
SPT

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Ring
Landmarks:
—
Directionality:
—

Nº Line's Colors:
12 colors
Streets/Ave.:
—
Background Area:
Geographic References
Geographic References:
Water

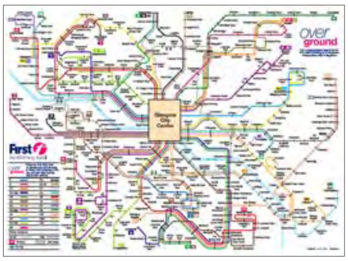
Typographic Level

Fonts:
AvantGardeITC/Frutiger/Myriad/Swiss721BT
Station Orientation:
0º
Route Labelling:
—

Route Orientation:
—
Terminus:

Glasgow| Glasgow Network Map; First

UK



CITY

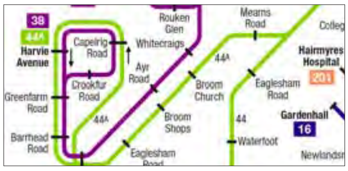
Population:
1.750.000
Area (km2) :
176

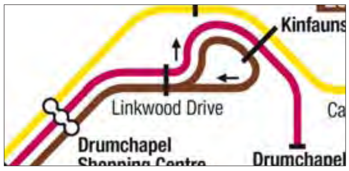
MAP

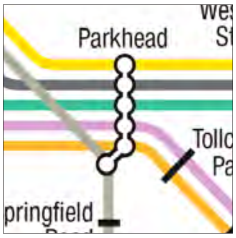
Institution:
SPT
System:
Glasgow Network Map; First
Year:
2007
Source:
www.spt.co.uk
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
62.993 x 44.395
Software:
——
Designer/Author:
——







DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Combination	**Stop/Station:**	**Nº Line's Colors:** 15 or More	**Fonts:** HelveticaNeue/T2	**Route Orientation:** Free Curve
Fidelity/Abstratcness: Cartographic	**Interchange:** ——	**Streets/Ave.:** Main Streets	**Station Orientation:** 0º	**Terminus:**
Fixed Angles: ——	**Landmarks:** Generic Point	**Background Area:** Geographic References	**Route Labelling:** 23	
	Directionality: 23	**Geographic References:** Water & Land		

Glasgow| Over Ground; First

UK

CITY

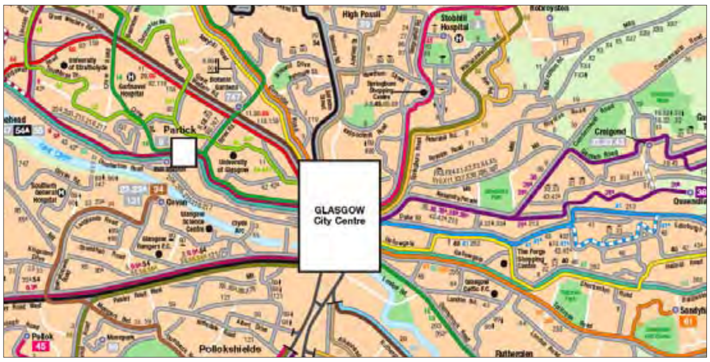
Population:
1.750.000
Area (km2) :
176

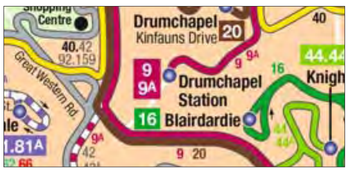
MAP

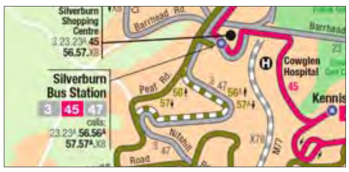
Institution:
SPT
System:
Over Ground; First
Year:
2006
Source:
www.spt.co.uk
Modes Number:
1
Modes:
Bus

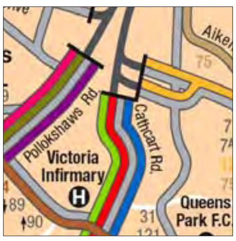
DOC. PROPERTIES

Format (cm):
42.011 x 29.700
Software:
——
Designer/Author:
Moira Bantock







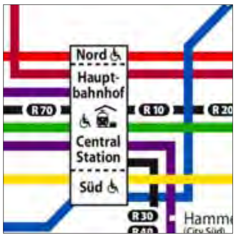


DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 15 or More	**Fonts:** HelveticaNeue	**Route Orientation:** ——
Fidelity/Abstratcness: Schematic	**Interchange:** String	**Streets/Ave.:** ——	**Station Orientation:** 0º	**Terminus:** 23 23
Fixed Angles: 0º/45º/90º	**Landmarks:** ——	**Background Area:** Geographic References	**Route Labelling:** ——	
	Directionality:	**Geographic References:** Water		

Hamburg| Rapid Transit/Regional Train

Germany



CITY

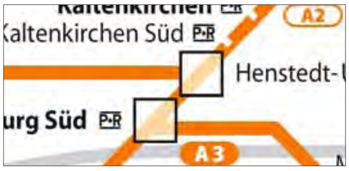
Population:
1.766.156
Area (km2) :
755

MAP

Institution:
HVV
System:
Rapid Transit/Regional Train
Year:
2007
Source:
www.hvv.de
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
43.477 x 31.178
Software:
——
Designer/Author:
wolfdietergreuel



DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 8 colors	**Fonts:** Myriad	**Route Orientation:** 0º
Fidelity/Abstractness: Schematic	**Interchange:** Regular Polygon	**Streets/Ave.:** ——	**Station Orientation:** Fixed Angles	**Terminus:**
Fixed Angles: 0º/45º/90º	**Landmarks:** ——	**Background Area:** Arbitrary	**Route Labelling:**	
	Directionality: ——	**Geographic References:** Water		

Hamburg| HVV Metro Buses

Germany

CITY

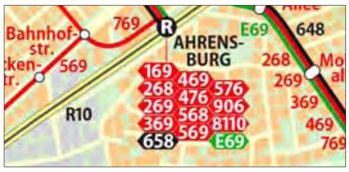
Population:
1.766.156
Area (km2) :
755

MAP

Institution:
HVV
System:
HVV Metro Buses
Year:
2007
Source:
www.hvv.de
Modes Number:
1
Modes:
Bus

Doc. Properties

Format (cm):
41.976 x 29.665
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Classic	**Stop/Station:** ——	**Nº Line's Colors:** 3 colors	**Fonts:** Frutiger/Myriad	**Route Orientation:** 0º
Fidelity/Abstractness: Cartographic	**Interchange:** ——	**Streets/Ave.:** Street Map	**Station Orientation:** ——	**Terminus:**
Fixed Angles: ——	**Landmarks:** ——	**Background Area:** Geographic References	**Route Labelling:**	
	Directionality: ——	**Geographic References:** Water & Land		

Hannover | Busnetz Germany

CITY

Population:
1.128.543
Area (km2) :
204

MAP

Institution:
GHV
System:
Stadbahnnetz
Year:
2006
Source:
www.gvh.de
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.700 x 20.996
Software:
——
Designer/Author:
——

Larger Exchange Point: Hauptbahnhof (N)

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
String
Landmarks:
——
Directionality:
——

Nº Line's Colors:
4 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
——

Typographic Level

Fonts:
Frutiger/ UstraGothic
Station Orientation:
Fixed Angles
Route Labelling:
23

Route Orientation:
0º
Terminus:
23
23
23

Helsinki | Bussilinjar; Esikaupungit Finland

CITY

Population:
568.146
Area (km2) :
187

MAP

Institution:
HKL
System:
Bussilinjar; Esikaupungit
Year:
2006
Source:
www.hel.fi/wps/portal/HKL
Modes Number:
4
Modes:
Metro-Rail/Bus/Tram/Ferry

DOC. PROPERTIES

Format (cm):
77.002 x 46.208
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
——
Directionality:

Nº Line's Colors:
3 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
HelveticaNeue/Times
Station Orientation:
——
Route Labelling:
23

Route Orientation:
0º
Terminus:
23

Helsinki | Raitiolinjat ja keskustan bussilinjoja; Keskusta — Finland

CITY

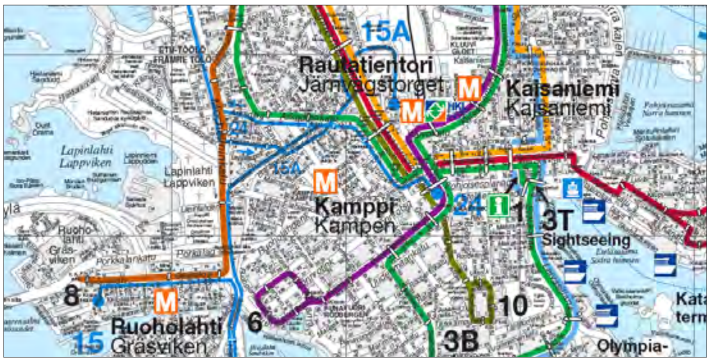
Population:
568.146
Area (km2) :
187

MAP

Institution:
HKL
System:
Raitiolinjat ja keskustan bussilinjoja; Keskusta
Year:
2006
Source:
www.hel.fi/wps/portal/HKL
Modes Number:
1
Modes:
Tram

DOC. PROPERTIES

Format (cm):
36.191 x 45.997
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:
Interchange:
Rings Stressed
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
8 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
HelveticaNeue/Times
Station Orientation:
——
Route Labelling:
23

Route Orientation:
0º
Terminus:

Hong Kong| MTR System Map — Hong Kong

CITY

Population:
6.963.100
Area (km2) :
686

MAP

Institution:
MTR
System:
System Map
Year:
2008
Source:
www.mtr.com.hk
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
21.469 x 15.399
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:
Interchange:
Rings Stressed
Landmarks:
Thematic Pictograms
Directionality:
——

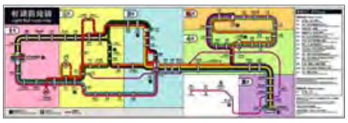
Nº Line's Colors:
11 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Hong Kong| Light Rail Route Map Hong Kong



CITY

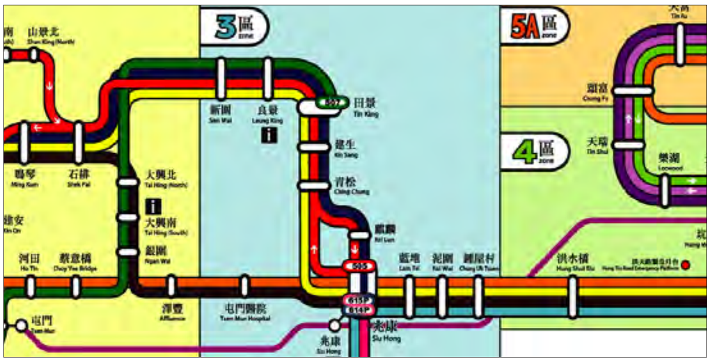
Population:
6.963.100
Area (km2) :
686

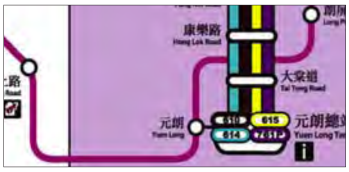
MAP

Institution:
MTR
System:
Light Rail Route Map
Year:
2008
Source:
www.mtr.com.hk
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
21.469 x 15.399
Software:
—
Designer/Author:
—





DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
14 colors
Streets/Ave.:
—
Background Area:
Tariff & System Zones
Geographic References:
—

Typographic Level

Fonts:
—
Station Orientation:
0º
Route Labelling:
—

Route Orientation:
—
Terminus:

Istambul| Rail System Network Map Turkey

CITY

Population:
11.912.511
Area (km2) :
1539

MAP

Institution:
IstanbulUlasim
System:
Rail System Network Map
Year:
—
Source:
www.istanbul-ulasim.com.tr/en/
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
42.011 x 29.700
Software:
—
Designer/Author:
tanoren

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
7 colors
Streets/Ave.:
—
Background Area:
Geographic References
Geographic References:
Water

Typographic Level

Fonts:
—
Station Orientation:
Fixed Angles
Route Labelling:
—

Route Orientation:
—
Terminus:

Istambul| Rail System Geographical Map

Turkey

CITY

Population:
11.912.511
Area (km2) :
1539

MAP

Institution:
IstanbulUlasim
System:
Rail System Geographical Map
Year:
——
Source:
www.istanbul-ulasim.com.tr/en/
Modes Number: 1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
42,011 x 29,700
Software:
——
Designer/Author:
tanoren

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 6 colors	**Fonts:** ——	**Route Orientation:** ——
Fidelity/Abstractness: Simplified	**Interchange:** Rings Connected	**Streets/Ave.:** ——	**Station Orientation:** Fixed Angles	**Terminus:**
Fixed Angles: ——	**Landmarks:** ——	**Background Area:** Geographic References	**Route Labelling:** ——	
	Directionality: ——	**Geographic References:** Water		

Karlsruhe| Liniennetzplan

Germany

CITY

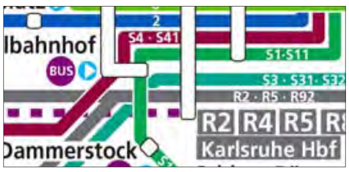
Population:
285.812
Area (km2) :
173

MAP

Institution:
KVV
System:
Rail System Network Map
Year:
2006
Source:
www.kvv.de
Modes Number:
2
Modes:
Metro-Rail/Tram

DOC. PROPERTIES

Format (cm):
42.046 x 29.418
Software:
FreeHand 10.0
Designer/Author:
——



DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 14 colors	**Fonts:** Frutiger/Helvetica	**Route Orientation:** Fixed Angles
Fidelity/Abstractness: Schematic	**Interchange:** Rings Stressed	**Streets/Ave.:** ——	**Station Orientation:** Fixed Angles	**Terminus:** 23 23
Fixed Angles: 0º/45º/90º	**Landmarks:** Illustration	**Background Area:** Geographic References	**Route Labelling:** 23	
	Directionality:	**Geographic References:** Water		

Koln | Busnetz

Germany

CITY

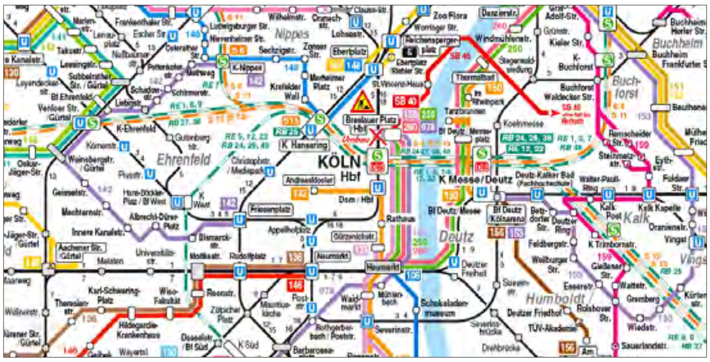
Population:
991.395
Area (km2) :
405

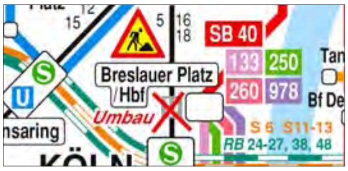
MAP

Institution:
VRS
System:
Busnetz
Year:
2006
Source:
www.vrsinfo.de
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
39.995 x 38.995
Software:
Adobe Illustrator CS2
Designer/Author:
——





DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

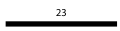
Graphic Level

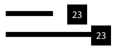
Stop/Station:

Interchange:
Regular Polygon
Landmarks:
——
Directionality:
Other

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water + North

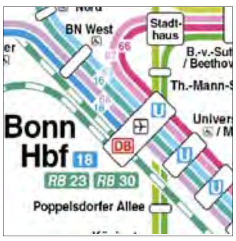
Typographic Level

Fonts:
Frutiger/Helvetica/Times
Station Orientation:
0º
Route Labelling:


Route Orientation:
0º
Terminus:


Koln | Schnellverkehr Verkehrsverbund Rhein-Sieg

Germany



CITY

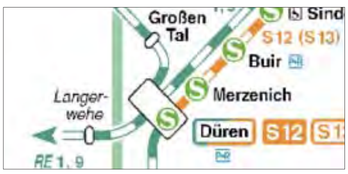
Population:
991.395
Area (km2) :
405

MAP

Institution:
VRS
System:
Schnellverkehr Verkehrsverbund Rhein-Sieg
Year:
2008
Source:
www.vrsinfo.de
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
39.995 x 38.995
Software:
Adobe Illustrator CS2
Designer/Author:
——

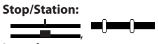


DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

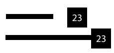
Graphic Level

Stop/Station:

Interchange:
Regular Polygon
Landmarks:
——
Directionality:
——

Nº Line's Colors:
14 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water + North

Typographic Level

Fonts:
Helvetica
Station Orientation:
Fixed Angles
Route Labelling:


Route Orientation:
0º
Terminus:


Leipzig| (Bus & Tram Network) Germany

CITY

Population:
508.605
Area (km2) :
297

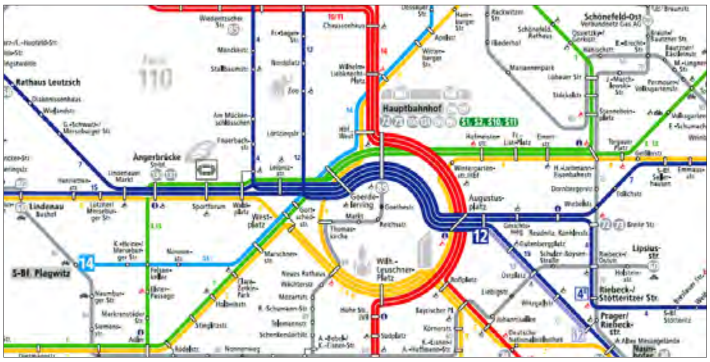
MAP

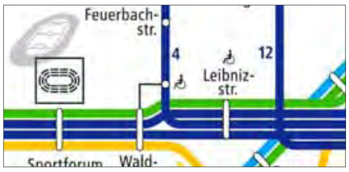
Institution:
LVB
System:
——

Year:
2007
Source:
www.lvb.de
Modes Number:
2
Modes:
Bus/Tram

DOC. PROPERTIES

Format (cm):
41.995 x 29.697
Software:
Adobe Illustrator
Designer/Author:
——





DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
Illustration/ Thematic pic.
Directionality:
——

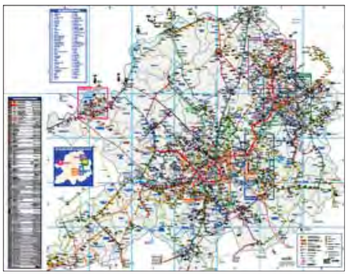
Nº Line's Colors:
5 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
——

Typographic Level

Fonts:
AvantGardeITC/Avenir/Frutiger/Futura/Geometric415BT/GillSans/Helvetica/MetaPlus
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
0º
Terminus:
23
23

Lille| System Map France



CITY

Population:
1.000.900
Area (km2) :
450

MAP

Institution:
Transpole
System:
——

Year:
2008
Source:
www.transpole.fr
Modes Number:
3
Modes:
Metro-Rail/Bus/Tram

DOC. PROPERTIES

Format (cm):
79.991 x 59.993
Software:
Adobe InDesign CS2
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
Illustration
Directionality:

Nº Line's Colors:
14 colors
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land

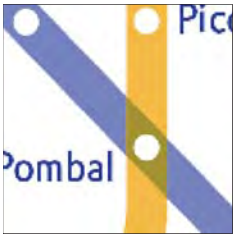
Typographic Level

Fonts:
Metropolis
Station Orientation:
0º
Route Labelling:
23
23
23

Route Orientation:
Free
Terminus:

Lisboa | Diagrama de Rede

Portugal



CITY

Population:
564.477
Area (km2) :
84

MAP

Institution:
Metropolitano de Liboa
System:
Network Diagram (Diagrama da rede)
Year:
2007
Source:
www.metrolisboa.pt
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.697 x 20.998
Software:
Adobe Illustrator CS3
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Color Overprint
Landmarks:
——
Directionality:
——

Nº Line's Colors:
4 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water

Typographic Level

Fonts:
Metropolis
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Lisboa | City Map

Portugal

CITY

Population:
564.477
Area (km2) :
84

MAP

Institution:
Metropolitano de Liboa
System:
City Map
Year:
2007
Source:
www.metrolisboa.pt
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.697 x 20.998
Software:
Adobe Illustrator CS3
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Dot
Landmarks:
Illustration
Directionality:
——

Nº Line's Colors:
4 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
Water & Land + North

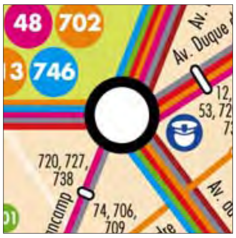
Typographic Level

Fonts:
Futura
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Lisboa | Mapa de Rede Carris

Portugal



CITY

Population:
564.477
Area (km2) :
84

MAP

Institution:
Carris
System:
Mapa de Rede Carris
Year:
2008
Source:
www.carris.pt
Modes Number:
3
Modes:
Metro-Rail/Bus/Funicular

DOC. PROPERTIES

Format (cm):
69.489 x 83.457
Software:
—
Designer/Author:
—

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Simplified
Fixed Angles:
—

Graphic Level

Stop/Station:

Interchange:
Ring,Rings Connected,Rings Stressed
Landmarks:
Thematic Pictograms
Directionality:
—

Nº Line's Colors:
15 or More
Streets/Ave.:
Main Streets
Background Area:
Politic
Geographic References:
Water & Land + North

Typographic Level

Fonts:
LogosPiFont/NJFont/TfLS-ymbolls
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
0º
Terminus:
23
23
23

London | Tub Map

UK

CITY

Population:
7.512.400
Area (km2) :
1577

MAP

Institution:
Transport for London
System:
Tube map; Oyster
Year:
2007
Source:
www.tfl.gov.uk
Modes Number:
2
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
124.447 x 99.756
Software:
Adobe Illustrator CS2
Designer/Author:
Transport for London

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
Pictograms
Directionality:
—

Nº Line's Colors:
11 colors
Streets/Ave.:
—
Background Area:
Tariff & System Zones
Geographic References:
Water

Typographic Level

Fonts:
NJFont/Univers
Station Orientation:
0º
Route Labelling:
—

Route Orientation:
—
Terminus:

London | (Central London Network) UK

CITY

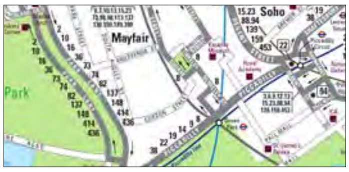
Population:
7.512.400
Area (km2) :
1577

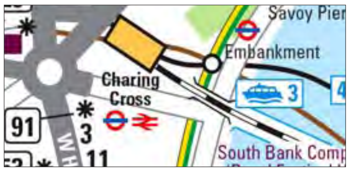
MAP

Institution:
Transport for London
System:
——
Year:
2007
Source:
www.tfl.gov.uk
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
47.437 x 33.490
Software:
——
Designer/Author:
Transport for London





DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:
Interchange:
Ring
Landmarks:
Generic Point
Directionality:

Nº Line's Colors:
11 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
DIN/ScalaSans
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
0º
Terminus:
Other

Los Angeles| 12 Minute Map USA

CITY

Population:
12.950.129
Area (km2) :
4.320

MAP

Institution:
Metro (Los Angeles Couty Metropolitan Transportation Authority)
System:
12 Minute Map
Year:
2008
Source:
www.metro.net
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
62.244 x 43.274
Software:
Adobe InDesign
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:
Interchange:
Rings Stressed
Landmarks:
Generic Point
Directionality:

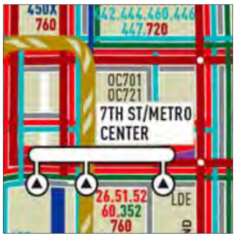
Nº Line's Colors:
8 colors
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
DIN
Station Orientation:
0º
Route Labelling:
23
23
23

Route Orientation:
0º
Terminus:

Los Angeles| System Map USA



CITY

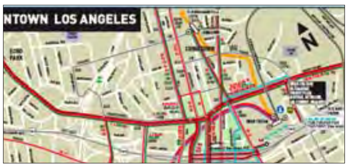
Population:
12.950.129
Area (km2) :
4.320

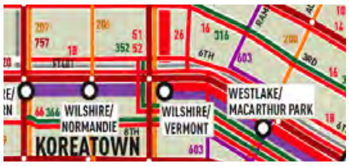
MAP

Institution:
Metro (Los Angeles Couty Metropolitan Transportation Authority)
System:
System Map
Year:
2008
Source:
www.metro.net
Modes Number: 2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
107.937 x 87.620
Software:
———
Designer/Author:
Metro Communications





DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Combination	**Stop/Station:**	**Nº Line's Colors:** 15 or More	**Fonts:** DIN	**Route Orientation:** 0º
Fidelity/Abstratcness: Simplified	**Interchange:** Rings Stressed	**Streets/Ave.:** Highways & Avenues	**Station Orientation:** 0º	**Terminus:** Other
Fixed Angles: ———	**Landmarks:** Generic Point	**Background Area:** Geographic References	**Route Labelling:** 23	
	Directionality:	**Geographic References:** Water & Land + North		

Los Angeles| Metro Rapid USA

CITY

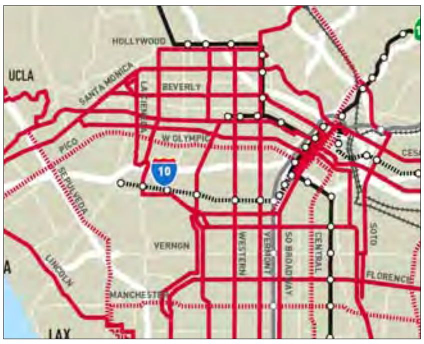
Population:
12.950.129
Area (km2) :
4.320

MAP

Institution:
Metro (Los Angeles Couty Metropolitan Transportation Authority)
System:
Metro Rapid
Year:
2008
Source:
www.metro.net
Modes Number:
1
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
27.937 x 21.587
Software:
Adobe Illustrator CS2
Designer/Author:
Metro Planning



DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 3 colors	**Fonts:** Futura/Garamond/Helvetica/Memphis/Univers	**Route Orientation:** ———
Fidelity/Abstratcness: Cartographic	**Interchange:** ———	**Streets/Ave.:** Highways & Avenues	**Station Orientation:** ———	**Terminus:** Other
Fixed Angles: ———	**Landmarks:** ———	**Background Area:** Geographic References	**Route Labelling:** ———	
	Directionality: ———	**Geographic References:** Water & Land + North		

Lyon| Agglonération France

CITY

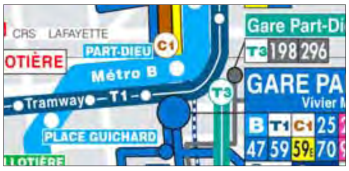
Population:
470.000
Area (km2) :
48

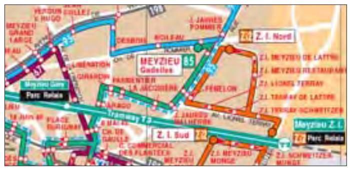
MAP

Institution:
TCL
System:
Agglonération
Year:
2006
Source:
www.tcl.fr
Modes Number:
4
Modes:
Metro-Rail/Bus/Tram/Ferry

DOC. PROPERTIES

Format (cm):
96.193 x 78.203
Software:
FreeHand MX 11.0.1
Designer/Author:
TCL Transports en Commun Lyonnais





DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
———

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Main Streets
Background Area:
Politic
Geographic References:
Water

Typographic Level

Fonts:
Helvetica/Memphis/Symbol/ Univers
Station Orientation:
0º
Route Labelling:

23
23
23

Route Orientation:
Free
Terminus:

Lyon| Métro - Tramway - Cristalis; MTC France

CITY

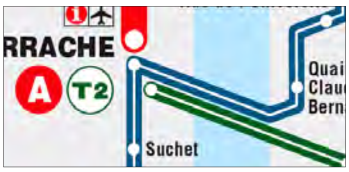
Population:
470.000
Area (km2) :
48

MAP

Institution:
TCL
System:
Métro - Tramway - Cristalis; MTC
Year:
2006
Source:
www.tcl.fr
Modes Number: 3
Modes:
Metro-Rail/Tram/Bus

DOC. PROPERTIES

Format (cm):
15.027 x 18.025
Software: FreeHand MX 11.0.1
Designer/Author:
TCL : Transports en Commun Lyonnais



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
20º/90º

Graphic Level

Stop/Station:

Interchange:
Ring
Landmarks:
———
Directionality:
———

Nº Line's Colors:
10 colors
Streets/Ave.:
———
Background Area:
Geographic References
Geographic References:
Water

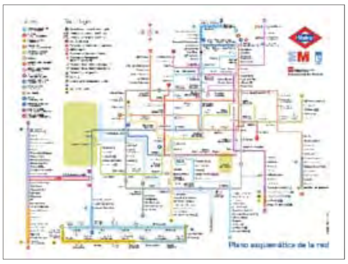
Typographic Level

Fonts:
Helvetica/ Symbol/ Univers
Station Orientation:
0º
Route Labelling:
———

Route Orientation:
———
Terminus:

23
23
23

Madrid | Red de Metro y Metro Ligero — Spain



CITY

Population:
3.228.359
Area (km2) :
607

MAP

Institution:
CTM (Consorcio Transportes Madrid)
System:
Red de Metro y Metro Ligero
Year:
2007
Source:
www.ctm-madrid.es
Modes Number:
2
Modes:
Metro-Rail/Tram

DOC. PROPERTIES

Format (cm):
26.526 x 19.091
Software:
Adobe Illustrator CS2
Designer/Author:
ray (RaRo)

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
——
Directionality:
——

Nº Line's Colors:
12 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
Myriad/OfficinaSans/Web-dings/ZurichBT
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Madrid | Red de Metro y Metro Ligero — Spain

CITY

Population:
3.228.359
Area (km2) :
607

MAP

Institution:
CTM (Consorcio Transportes Madrid)
System:
Red de Metro y Metro Ligero
Year:
2008
Source:
www.ctm-madrid.es
Modes Number:
1
Modes:
Metro-Rail/Tram

DOC. PROPERTIES

Format (cm):
28.197 x 30.696
Software:
FreeHand MX
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Ring Stressed, Area
Landmarks:
——
Directionality:
——

Nº Line's Colors:
13 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
Water

Typographic Level

Fonts:
FoundryGridnik/Helvetica
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:
23
23

Manchester| Greater Manchester Local Rail — UK

CITY

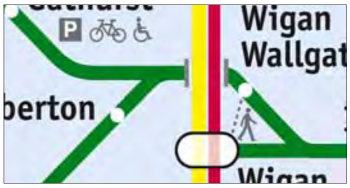
Population:
452.000
Area (km2) :
116

MAP

Institution:
Metrolink
System:
Greater Manchester Local Rail Network
Year:
2007
Source:
www.metrolink.co.uk
Modes Number:
2
Modes:
Metro-Rail/Tram

DOC. PROPERTIES

Format (cm):
29.697 x 20.998
Software:
Adobe Illustrator CS2
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Color Overprint
Landmarks:
——
Directionality:
——

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Politic
Geographic References:
——

Typographic Level

Fonts:
OfficinaSans/ZurichBT
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Manchester | (GMPTE Network) — UK

CITY

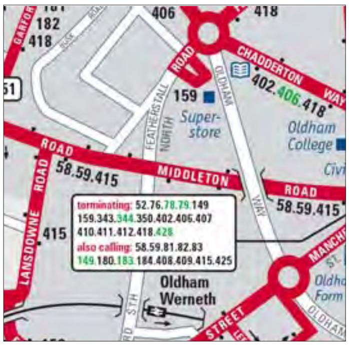
Population:
452.000
Area (km2) :
116

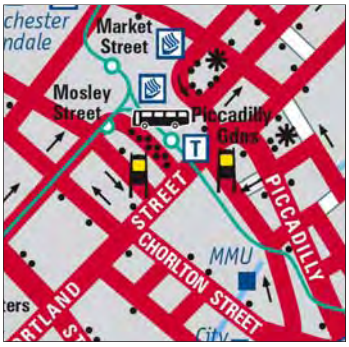
MAP

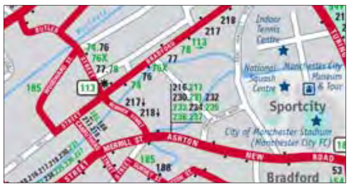
Institution:
GMPTE
System:
——
Year:
2007
Source:
www.gmpte.com/
Modes Number:
2
Modes:
Metro-Rail/Tram

DOC. PROPERTIES

Format (cm):
120.672 x 85.398
Software:
Adobe Illustrator CS2
Designer/Author:
——







DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
2 colors
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
OfficinaSans/ZurichBT
Station Orientation:
——
Route Labelling:
23

Route Orientation:
Free
Terminus:
——

Medellin | Metro System

Colombia

CITY

Population:
2.223.078
Area (km2) :
381

Map
Institution:
Metro
System:
——
Year:
——
Source:
www.metrodemedellin.org.com
Modes Number:
1
Modes:
Metro-Rail

Doc. Properties
Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Regular Polygon
Landmarks:
——
Directionality:
——

Nº Line's Colors:
5 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water + North

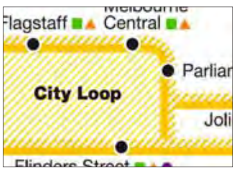
Typographic Level

Fonts:
HelveticaNeue
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Melbourne | Train Network

Australia

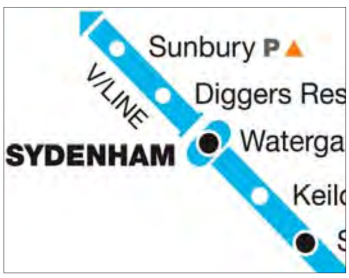


CITY

Population:
3.744.373
Area (km2) :
37

MAP
Institution:
Metlink
System:
Melbourne Train Network
Year:
2007
Source:
www.metlinkmelbourne.com.au
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES
Format (cm):
16.096 x 22.219
Software:
Adobe Illustrator CS2
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Concentric Rings
Landmarks:
——
Directionality:
——

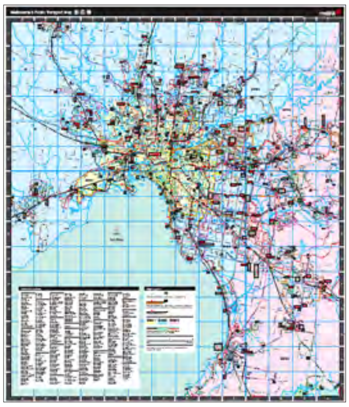
Nº Line's Colors:
2 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
North

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Melbourne | Train Network — Australia



CITY

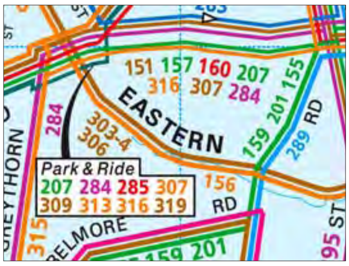
Population:
3.744.373
Area (km2) :
37

MAP

Institution:
Metlink
System:
Melbourne Public Transport Map
Year:
2006
Source:
metlinkmelbourne.com.au
Modes Number:
3
Modes:
Metro-Rail/Bus/Tram

DOC. PROPERTIES

Format (cm):
20.996 x 29.700
Software:
——
Designer/Author:
Daren



DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
Pictograms
Directionality:

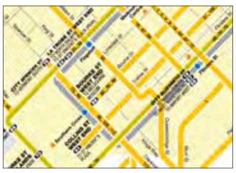
Nº Line's Colors:
10 colors
Streets/Ave.:
Main Streets
Background Area:
Tariff & System Zones
Geographic References:
Water & Land

Typographic Level

Fonts:
Helvetica
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
Free
Terminus:

Melbourne | Tram Network — Australia



CITY

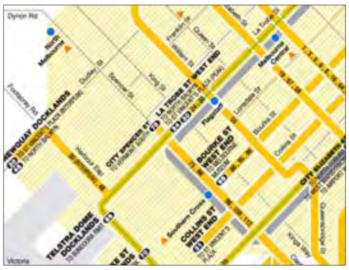
Population:
3.744.373
Area (km2) :
37

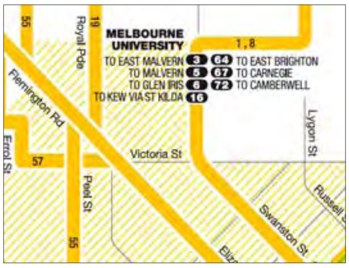
MAP

Institution:
Metlink
System:
Melbourne Tram Network
Year:
2007
Source:
www.metlinkmelbourne.com.au
Modes Number:
1
Modes:
Tram

DOC. PROPERTIES

Format (cm):
20.996 x 29.700
Software:
Adobe Illustrator CS2
Designer/Author:
Helen Radloff





DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
——
Directionality:
——

Nº Line's Colors:
3 colors
Streets/Ave.:
Main Streets
Background Area:
Tariff & System Zones
Geographic References:
North

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:
23

Route Orientation:
Fixed Angles
Terminus:

Mexico D.F. | Red del Metro   Mexico

CITY

Population:
19.231.829
Area (km2) :
1479

MAP

Institution:
Metro de la Ciudad de Mexico - STC (Sistema de Transporte Colectivo)/ RTP (Red de Transporte de pasajeros)
System:
Red del Metro
Year:
2003
Source:
www.metro.df.gob.mx
Modes Number:1
Modes: Metro-Rail

DOC. PROPERTIES

Format (cm):
21.587 x 27.937
Software:
CorelDraw
Designer/Author:
S.T.C. metro

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 10 colors	**Fonts:** Century/Frutiger/Helvetica	**Route Orientation:** 0º
Fidelity/Abstractness: Simplified	**Interchange:** Pie	**Streets/Ave.:** Main Streets	**Station Orientation:** Free	**Terminus:**
Fixed Angles: ——	**Landmarks:** ——	**Background Area:** ——	**Route Labelling:** ——	
	Directionality: ——	**Geographic References:** North		

Miami | Transit Integrated System   USA

CITY

Population:
4.919.036
Area (km2) :
143

MAP

Institution:
DADE
System:
Miami-Dade Transit Integrated System
Year:
2006
Source:
www.miamidade.gov/transit/
Modes Number:
3
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
87.620 x 81.271
Software:
QuarkXPress
Designer/Author:
julio

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 15 or More	**Fonts:** Century/Frutiger/Helvetica	**Route Orientation:** 0º
Fidelity/Abstractness: Simplified	**Interchange:** ——	**Streets/Ave.:** Main Streets	**Station Orientation:** 0º	**Terminus:** Other
Fixed Angles: ——	**Landmarks:** ——	**Background Area:** Geographic References	**Route Labelling:**	
	Directionality:	**Geographic References:** Water + North		

Milan | Rete metropolitana e tratte ferroviarie urbane

USA

CITY

Population:
1.303.437
Area (km2) :
182

MAP

Institution:
ATM
System:
Rete metropolitana e tratte ferroviarie urbane
Year:
2005
Source:
www.atm-mi.it
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
64.992 x 44.995
Software:
Adobe Illustrator
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
1,Rings Stressed
Landmarks:
——
Directionality:
——

Nº Line's Colors:
6 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
——

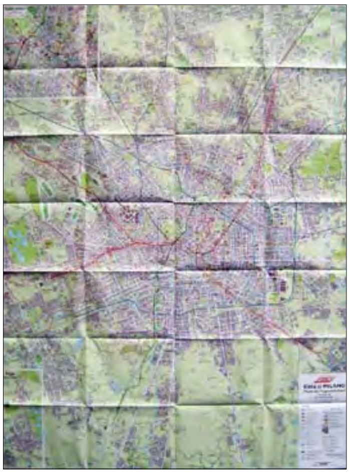
Typographic Level

Fonts:
Garamond/Univers
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Milan | Rete metropolitana e tratte ferroviarie urbane

USA



CITY

Population:
1.303.437
Area (km2) :
182

MAP

Institution:
ATM
System:
Rete metropolitana e tratte ferroviarie urbane
Year:
2005
Source:
www.atm-mi.it
Modes Number:
3
Modes:
Metro-Rail/Bus/Tram

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

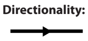
Structural Level

Style:
Combination
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

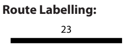
Interchange:
Ring
Landmarks:
Pictograms
Directionality:



Nº Line's Colors:
5 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:



Route Orientation:
Free
Terminus:
——

Montreal | Canada

CITY

City:
Montreal
Population:
1.620.693
Area (km2) :
365

MAP

Institution:
STM
System:
——

Year:
2007
Source:
www.stm.info
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
178.788 x 83.253
Software:
Adobe Illustrator CS2
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Pie
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
5 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Garamond/Univers
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
Free Curve
Terminus:
——

Montreal | Canada

CITY

Population:
1.620.693
Area (km2) :
365

MAP

Institution:
——

System:
——

Year:
2005
Source:
www.stm.info
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
21.164 x 25.326
Software:
——

Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Ring
Landmarks:
——

Directionality:
——

Nº Line's Colors:
5 colors
Streets/Ave.:
——

Background Area:
Geographic References
Geographic References:
North

Typographic Level

Fonts:
——

Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——

Terminus:

Moscow | Rapid Transit Systems of Moscow

Russia

CITY

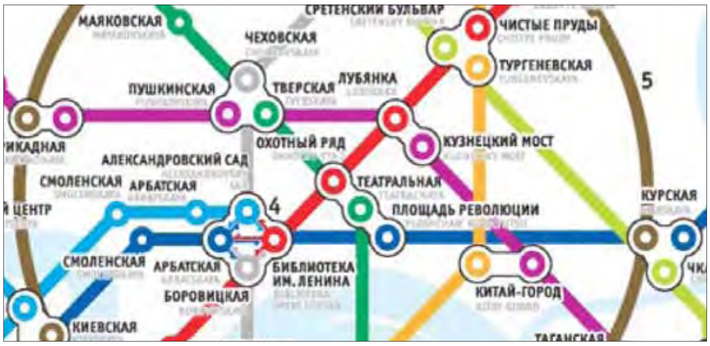
Population:
10.462.424
Area (km2) :
1081

MAP

Institution:
Metro
System:
Rapid Transit Systems of Moscow
Year:
2008
Source:
www.mosmetro.ru
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
35.375 x 40.101
Software:
—
Designer/Author:
—



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
—
Directionality:
—

Nº Line's Colors:
11 colors
Streets/Ave.:
—
Background Area:
Geographic References
Geographic References:
Water

Typographic Level

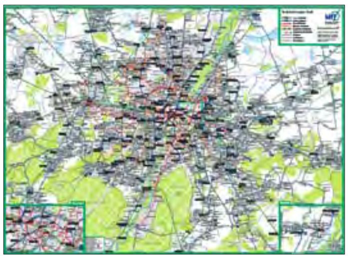
Fonts:
—
Station Orientation:
Fixed Angles
Route Labelling:
—

Route Orientation:
—
Terminus:

Last Edition March 2009 | **Nº77**

Munich | Verkehrslinienplan Stadt

Germany



CITY

Population:
1.348.650
Area (km2) :
310

MAP

Institution:
MVV
System:
Verkehrslinienplan Stadt
Year:
2008
Source:
www.mvv-muenchen.de
Modes Number:
3
Modes:
Metro-Rail/Bus/Tram

DOC. PROPERTIES

Format (cm):
57.672 x 40.494
Software:
CorelDraw
Designer/Author:
MVV

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Cartographic
Fixed Angles:
—

Graphic Level

Stop/Station:

Interchange:
Ring, Pie
Landmarks:
—
Directionality:

Nº Line's Colors:
6 colors
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Futura/Swiss721BT/ZurichBT
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
Free
Terminus:

Last Edition March 2009 | **Nº78**

Munich | Schnellbahnnetz — Germany

CITY

Population: 1.348.650
Area (km2) : 310

MAP

Institution: MVV
System: Schnellbahnnetz
Year: 2008
Source: www.mvv-muenchen.de
Modes Number: 1
Modes: Metro-Rail

DOC. PROPERTIES

Format (cm): 29.771 x 21.058
Software: CorelDraw
Designer/Author: MVV

DESIGN LEVELS

Structural Level

Style: French
Fidelity/Abstratcness: Schematic
Fixed Angles: 0º/45º/90º

Graphic Level

Stop/Station:
Interchange: Rings Stressed
Landmarks: Illustration/ Thematic pic.
Directionality: ——

Nº Line's Colors: 11 colors
Streets/Ave.: ——
Background Area: Tariff & System Zones
Geographic References: Water

Typographic Level

Fonts: ViaLogLT/ZurichBT
Station Orientation: 0º
Route Labelling: ——

Route Orientation: ——
Terminus:

Munich | Tramnetz München — Germany

CITY

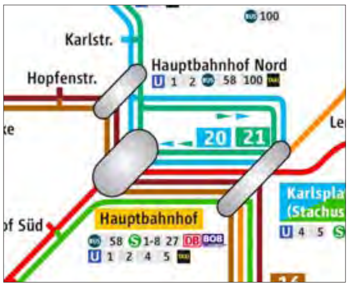
Population: 1.348.650
Area (km2) : 310

MAP

Institution: MVV
System: Tramnetz München
Year: 2007
Source: www.mvv-muenchen.de
Modes Number: 1
Modes: Tram

DOC. PROPERTIES

Format (cm): 119.151 x 83.945
Software: CorelDraw
Designer/Author: fischer.helmut



DESIGN LEVELS

Structural Level

Style: French
Fidelity/Abstratcness: Schematic
Fixed Angles: 0º/45º/90º

Graphic Level

Stop/Station:
Interchange: Rings Stressed
Landmarks: Illustration/ Thematic pic.
Directionality: ——

Nº Line's Colors: 10 colors
Streets/Ave.: ——
Background Area: Geographic References
Geographic References: Water

Typographic Level

Fonts: ArialMT/ViaLogLT
Station Orientation: 0º
Route Labelling: ——

Route Orientation: ——
Terminus:

Nagoya | Metro System — Japan

CITY

Population:
2.190.549
Area (km2) :
326

MAP

Institution:
Kotsu (City of Nagoya Transportation Bureau)
System:
—

Year:
2008
Source:
www.kotsu.city.nagoya.jp
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
20.988 x 24.268
Software:
Photoshop 5.0
Designer/Author:
—

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 7 colors	**Fonts:** —	**Route Orientation:** —
Fidelity/Abstratcness: Simplified	**Interchange:** Ring, Regular Polygon	**Streets/Ave.:** —	**Station Orientation:** 0º	**Terminus:**
Fixed Angles: —	**Landmarks:** —	**Background Area:**	**Route Labelling:** —	
	Directionality: —	**Geographic References:** —		

Naples | Systema Metronapoli — Italy

CITY

Population:
975.139
Area (km2) :
117

MAP

Institution:
Metro / CTP (Compagnia Trasporti Pubblici)
System:
—

Year:
2008
Source:
www.metro.na.it
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
35.521 x 42.716
Software:
Photoshop CS
Designer/Author:
—

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:**	**Nº Line's Colors:** 4 colors	**Fonts:** —	**Route Orientation:** 0º
Fidelity/Abstratcness: Schematic	**Interchange:** Ring	**Streets/Ave.:** —	**Station Orientation:** Fixed Angles	**Terminus:** Other
Fixed Angles: 0º/30º/45º/90º	**Landmarks:** —	**Background Area:** —	**Route Labelling:**	
	Directionality: —	**Geographic References:** —		

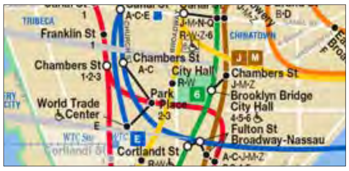
New York | MTA Subway USA

CITY

Population:
1.537.195
Area (km2) :
88

MAP
Institution:
MTA (Metropolitan Transportation Authority)
System:
MTA New York City Subway
Year:
2007
Source:
www.mta.info
Modes Number:
2
Modes:
Metro-Rail/Boat

DOC. PROPERTIES
Format (cm):
55.513 x 69.644
Software:
Adobe Illustrator
Designer/Author:
Chuck Gordanier



DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Rings Stressed, Connected
Landmarks:
——
Directionality:
——

Nº Line's Colors:
11 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
BulletFontNew/Cheltenham/Helvetica/MetaPlus/Mini-PicsInternational/Myriad/NYCTABullet
Station Orientation:
Fixed Angles

Route Labelling:
23
Route Orientation:
0º
Terminus:
23
23

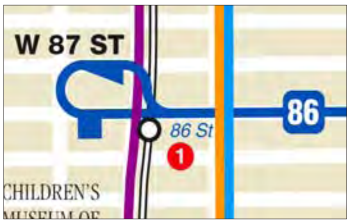
New York| MTA Manhattan Bus Map USA

CITY

Population:
1.537.195
Area (km2) :
88

MAP
Institution:
MTA (Metropolitan Transportation Authority)
System:
MTA Manhattan Bus Map
Year:
2007
Source:
www.mta.info
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES
Format (cm):
27.619 x 85.080
Software:
——
Designer/Author:
NYC Transit Mapping



DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
Generic Point
Directionality:
3d, 4d

Nº Line's Colors:
6 colors
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
Garamond/Helvetica/Palatino
Station Orientation:
0º
Route Labelling:
23
23
23

Route Orientation:
0º
Terminus:

Osaka | Network System

Japan

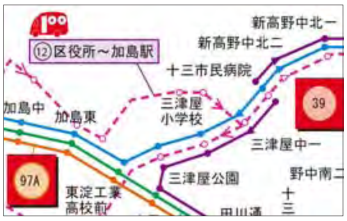
CITY

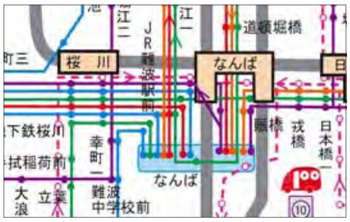
Population:
19.220.000
Area (km2) :
222

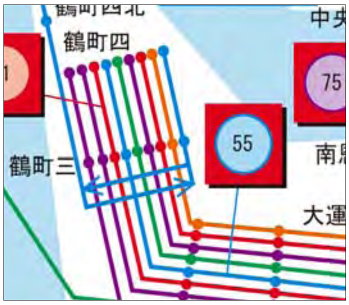
MAP
Institution:
Kotsu
System:
—

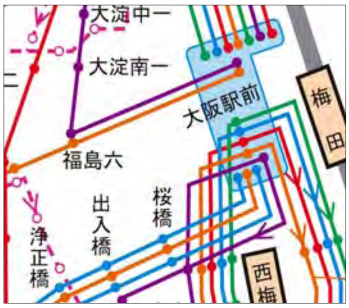
Year:
2006
Source:
www.kotsu.city.osaka.jp
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES
Format (cm):
14.584 x 17.501
Software:
Adobe Illustrator CS2
Designer/Author:
—









DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Simplified
Fixed Angles:
—

Graphic Level

Stop/Station:

Interchange:
—
Landmarks:
—
Directionality:

Nº Line's Colors:
6 colors
Streets/Ave.:
—
Background Area:
Geographic References
Geographic References:
Water + North

Typographic Level

Fonts:
FutoGoB101/GothicBB/GothicMB101/Helvetica/Midashi-Go/ShinGo
Station Orientation:
—
Route Labelling:
23

Route Orientation:
0º
Terminus:

Osaka | Metro System

Japan

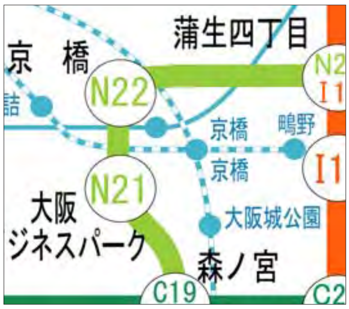
CITY

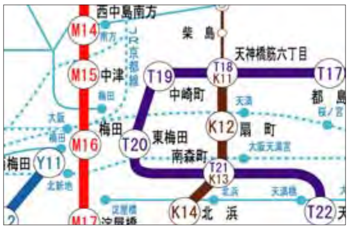
Population:
19.220.000
Area (km2) :
222

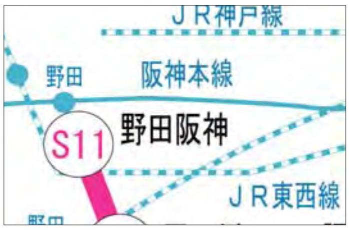
Map
Institution:
Kotsu/OKK
System:
—

Year:
2008
Source:
www.kotsu.city.osaka.jp
Modes Number:
2
Modes:
Metro-Rail

Doc. Properties
Format (cm):
29.697 x 20.998
Software:
Adobe Illustrator CS2
Designer/Author:
—







DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/30º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
—
Directionality:
—

Nº Line's Colors:
9 colors
Streets/Ave.:
—
Background Area:
—
Geographic References:
—

Typographic Level

Fonts:
—
Station Orientation:
?
Route Labelling:
—

Route Orientation:
—
Terminus:

Oslo | Busslinjer

Nordway

CITY

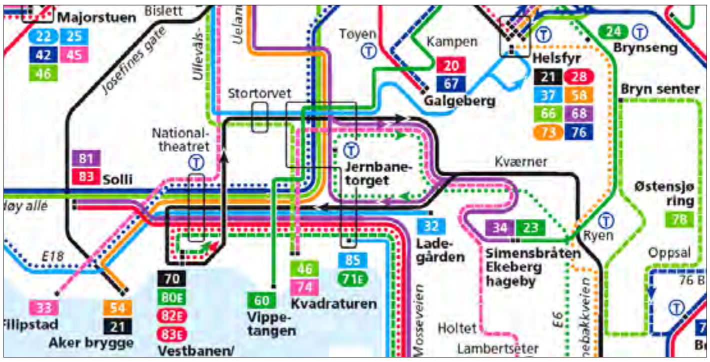
Population:
839.423
Area (km2) :
454

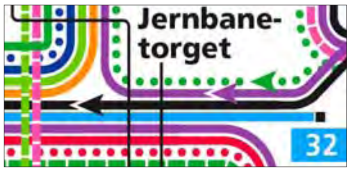
MAP

Institution:
Sporveier
System:
Busslinjer I Oslo
Year:
2006
Source:
www.sporveien.no/180/
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
18.998 x 18.998
Software:
Adobe InDesign CS (3.01)
Designer/Author:
—





DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: French	**Stop/Station:** —	**Nº Line's Colors:** 12 colors	**Fonts:** Frutiger	**Route Orientation:** 0º
Fidelity/Abstratcness: Schematic	**Interchange:** Area	**Streets/Ave.:** —	**Station Orientation:** Fixed Angles	**Terminus:**
Fixed Angles: 0º/45º/90º	**Landmarks:** —	**Background Area:** Geographic References	**Route Labelling:**	
	Directionality:	**Geographic References:** Water		

Oslo | Lokaltog | T-banen | Trikken

Nordway

CITY

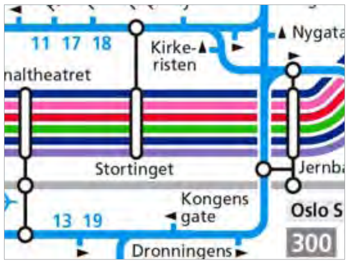
Population:
839.423
Area (km2) :
454

MAP

Institution:
Sporveier
System:
Lokaltog | T-banen | Trikken
Year:
2006
Source:
www.sporveien.no/180/
Modes Number:
3
Modes:
Metro-Rail/Tram

DOC. PROPERTIES

Format (cm):
18.998 x 18.998
Software:
Adobe InDesign CS (3.01)
Designer/Author:
—



DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Combination	**Stop/Station:**	**Nº Line's Colors:** 8 colors	**Fonts:** Frutiger	**Route Orientation:** 0º
Fidelity/Abstratcness: Schematic	**Interchange:** Rings Stressed, Connected	**Streets/Ave.:** —	**Station Orientation:** Fixed Angles	**Terminus:**
Fixed Angles: 0º/45º/90º	**Landmarks:** —	**Background Area:** Geographic References	**Route Labelling:**	
	Directionality:	**Geographic References:** Water		

Paris | Bus

France

CITY

Population:
2.167.994
Area (km2) :
86

MAP

Institution:
RATP
System:
Bus
Year:
2007
Source:
www.ratp.fr
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
38.595 x 38.195
Software:
Adobe Illustrator
Designer/Author:
CC83855

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:
——
Interchange:
Area
Landmarks:
——
Directionality:

Nº Line's Colors:
14 colors
Streets/Ave.:
Main Streets
Background Area:
Politic
Geographic References:
Water

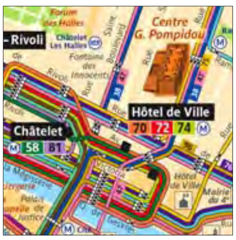
Typographic Level

Fonts:
Parisine
Station Orientation:
0º
Route Labelling:

Route Orientation:
Free
Terminus:

Paris | Bus | T

France



CITY

Population:
2.167.994
Area (km2) :
86

MAP

Institution:
RATP
System:
Bus | T
Year:
2007
Source:
www.ratp.fr
Modes Number:
2
Modes:
Bus/Tram

DOC. PROPERTIES

Format (cm):
127.985 x 98.988
Software:
——
Designer/Author:
CC83855

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
Pictograms, 3d
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Parisine
Station Orientation:
0º
Route Labelling:

Route Orientation:
Free
Terminus:

Paris | M | Rer | T France

CITY

Population:
2.167.994
Area (km2) :
86

MAP

Institution:
RATP
System:
M | Rer | T
Year:
2006
Source:
www.ratp.fr
Modes Number:
3
Modes:
Metro-Rail/Bus/Tram

DOC. PROPERTIES

Format (cm):
40.000 x 40.000
Software:
——
Designer/Author:
CC83855

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
2,Rings Stressed
Landmarks:
——
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Politic
Geographic References:
Water

Typographic Level

Fonts:
Parisine
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

23
23
23

Porto | Portugal

CITY

Population:
240.000
Area (km2) :
42

MAP

Institution:
Metro
System:
——
Year:
2008
Source:
www.metrodoporto.pt
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
85.362 x 114.287
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
——
Directionality:
——

Nº Line's Colors:
5 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
Water

Typographic Level

Fonts:
DIN
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

23
23
23

Prague |

Czech Republic

CITY

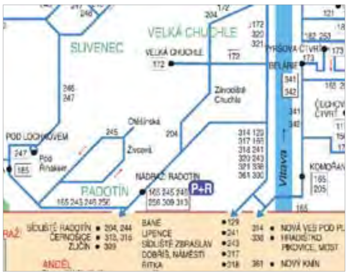
Population:
1.188.126
Area (km2) :
496

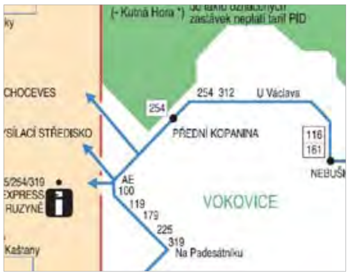
MAP

Institution:
Metro a autobusy Prazske integrovane dopravy
System:
—
Year:
—
Source:
www.dpp.cz
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
44.656 x 32.346
Software:
CorelDraw
Designer/Author:
DP-Praha





DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Combination	**Stop/Station:**	**Nº Line's Colors:** 5 colors	**Fonts:** —	**Route Orientation:** 0º
Fidelity/Abstratcness: Schematic	**Interchange:** Concentric Rings	**Streets/Ave.:** —	**Station Orientation:** 0º	**Terminus:**
Fixed Angles: 0º/45º/90º	**Landmarks:** —	**Background Area:** Geographic References	**Route Labelling:** 23	
	Directionality:	**Geographic References:** Water & Land		

Prague | Metro a Tramvaje

Czech Republic

CITY

Population:
1.188.126
Area (km2) :
496

MAP

Institution:
Prazske integrovane dopravy
System:
Metro a Tramvaje
Year:
2008
Source:
www.dpp.cz
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
43.477 x 31.178
Software:
Adobe Illustrator CS3
Designer/Author:
amos

DESIGN LEVELS

Structural Level	*Graphic Level*		*Typographic Level*	
Style: Combination	**Stop/Station:**	**Nº Line's Colors:** 4 colors	**Fonts:** —	**Route Orientation:** Free
Fidelity/Abstratcness: Simplified	**Interchange:** Concentric Rings	**Streets/Ave.:** —	**Station Orientation:** Fixed Angles	**Terminus:**
Fixed Angles: —	**Landmarks:** Pictograms	**Background Area:** Geographic References	**Route Labelling:** 23	
	Directionality: 23	**Geographic References:** Water		

Rhein-Ruhr | Linienplan Schnellverkehr   Germany

CITY

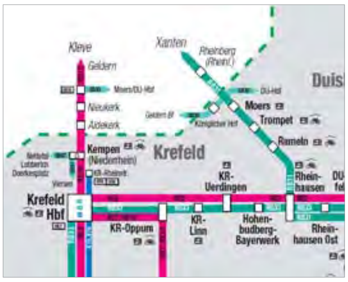
Population:
10.442
Area (km2) :
7826

MAP

Institution:
VRR
System:
Linienplan Schnellverkehr
Year:
2007
Source:
www.vrr.de
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
42.613 x 30.321
Software:
Adobe Illustrator CS2
Designer/Author:
helge hinniger



DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Regular Polygon
Landmarks:
——
Directionality:
——

Nº Line's Colors:
5 colors
Streets/Ave.:
——
Background Area:
Politic
Geographic References:
——

Typographic Level

Fonts:
Helvetica/ Courier
Station Orientation:
Fixed Angles
Route Labelling:
23

Route Orientation:
Fixed Angles
Terminus:

Rhein-Ruhr | Linienplan Dortmund   Germany

CITY

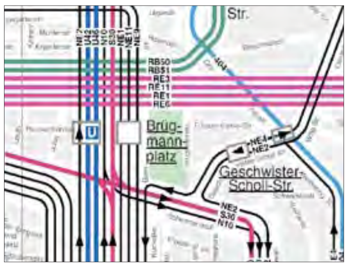
Population:
10.442
Area (km2) :
7826

MAP

Institution:
H-BAHN21
System:
Linienplan Dortmund
Year:
——
Source:
www.vrr.de
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
109.987 x 89.990
Software:
Adobe Illustrator
Designer/Author:
Christian Hippler



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Regular Polygon
Landmarks:
Illustration
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Helvetica
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
Free
Terminus:
23
23

Rio de Janeiro | Brazil

CITY

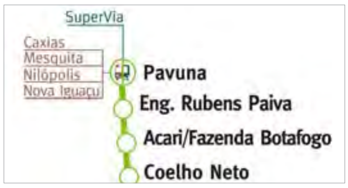
Population:
6.094.183
Area (km2) :
1182

MAP

Institution:
MetroRio
System:
——
Year:
2008
Source:
www.metrorio.com.br
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
——
Directionality:
——

Nº Line's Colors:
4 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Roma | RomaMetroPerMetro Italia

CITY

Population:
2.718.768
Area (km2) :
1285

MAP

Institution:
Metroroma / ATAC
System:
RomaMetroPerMetro
Year:
——
Source:
www.metroroma.it
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
20.812 x 20.811
Software:
Adobe Illustrator
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
——
Directionality:
——

Nº Line's Colors:
7 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
Water

Typographic Level

Fonts:
Frutiger/Helvetica
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Roma | Citta

Italia

CITY

Population:
2.718.768
Area (km2) :
1285

MAP
Institution:
RomaCitta
System:
——
Year:
——
Source:
www.metroroma.it
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES
Format (cm):
42.011 x 29.700
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
7 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
Free
Terminus:
Other

Salzburg | Linientzplan

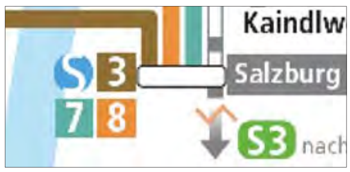
Austria

CITY

Population:
150.269
Area (km2) :
66

MAP
Institution:
SalzburgAG
System:
——
Year:
——
Source:
www.salzburg-ag.at
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES
Format (cm):
41.447 x 29.700
Software:
FreeHand 8.0.1
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Regular Polygon
Landmarks:
——
Directionality:

Nº Line's Colors:
9 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
Frutiger/ Transit
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
Fixed Angles
Terminus:

San Francisco | USA

CITY

Population:
739.426
Area (km2) :
601

MAP

Institution:
BART / SFMTA
System:
——
Year:
——
Source:
www.bart.gov
Modes Number:
1
Modes:
Metro-Rail

Doc. Properties

Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Regular Polygon
Landmarks:
——
Directionality:
——

Nº Line's Colors:
5 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

San Francisco | USA

CITY

Population:
739.426
Area (km2) :
601

MAP

Institution:
SFMTA
System:
——
Year:
——
Source:
www.sfmta.com
Modes Number:
4
Modes:
Metro-Rail/Tram/Bus/Ferry

DOC. PROPERTIES

Format (cm):
63.493 x 54.604
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
13 colors
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land

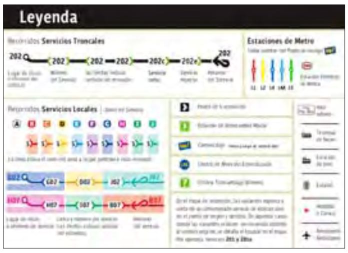
Typographic Level

Fonts:
StoneSerif/ Univers
Station Orientation:
——
Route Labelling:

Route Orientation:
Free
Terminus:

Santiago | Transantiago

Chile



CITY

Population:
5.428.590
Area (km2) :
641

MAP

Institution:
Transantiago
System:
Mapa de Recorridos Troncales y Locales del Gran Santiago
Year:
2007
Source:
www.transantiagoinforma.cl
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
67.992 x 88.010
Software:
FreeHand MX
Designer/Author:
Joel Gutierrez

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstratcness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Rings Connected,Pictogram
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Street Map
Background Area:
Politic
Geographic References:
Water & Land

Typographic Level

Fonts:
TSInfo/ TSMapa/ Helvetica
Station Orientation:
Fixed Angles
Route Labelling:

Route Orientation:
Free
Terminus:

Sao Paulo | Metropolintan Transport Network

Brazil

CITY

Population:
10.927.985
Area (km2) :
1523

MAP

Institution:
Metro / SPTrans
System:
Rede Metropolitana de Transporte
Year:
2006
Source:
www.metro.sp.gov.br
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.697 x 20.998
Software:
CorelDraw
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
3,Color Overprint
Landmarks:
——
Directionality:
——

Nº Line's Colors:
11 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water + North

Typographic Level

Fonts:
Arial MT
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Seoul | Metro lines in Seoul Metropolitan Area — South Korea

CITY

Population:
10.924.870
Area (km2) :
606

MAP

Institution:
Metro
System:
Metro lines in Seoul Metropolitan Area
Year:
——
Source:
www.seoulmetro.co.kr
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/30º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Pictogram
Landmarks:
——
Directionality:
——

Nº Line's Colors:
11 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Sevilla | Red de Líneas — España

CITY

Population:
699.759
Area (km2) :
141

MAP

Institution:
TUSSAM
System:
Red de Líneas
Year:
2007
Source:
www.tussam.es
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
42.011 x 29.700
Software:
——
Designer/Author:
GREGORIO

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
——
Landmarks:
3D
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land + North

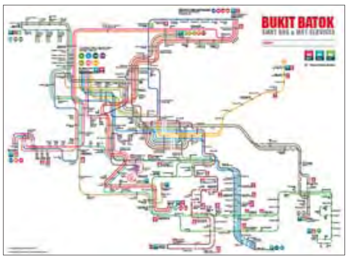
Typographic Level

Fonts:
Gen.Helvetica/Gen.Univers/Gen_Arial/Gen_ZapfChan
Station Orientation:
——
Route Labelling:

Route Orientation:
Free
Terminus:

Singapore | Bukit Batok SMRT Bus & MRT Services

Singapore

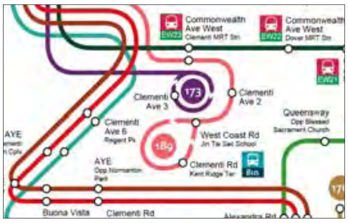


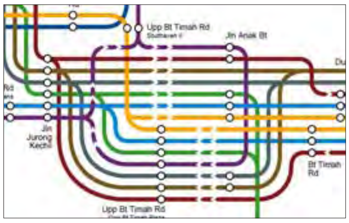
CITY

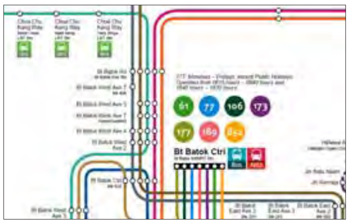
Population:
4.425.720
Area (km2) :
693

MAP
Institution:
SMRT
System:
BUKIT BATOK
Year:
2007
Source:
www.smrt.com.sg
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES
Format (cm):
41.976 x 29.665
Software:
—
Designer/Author:
—







DESIGN LEVELS

Structural Level | *Graphic Level* | *Typographic Level*

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Stop/Station:
Interchange:
—
Landmarks:
—
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
—
Background Area:
—
Geographic References:
—

Fonts:
Arial/BlissCaps/Impact
Station Orientation:
0º
Route Labelling:
—

Route Orientation:
—
Terminus:
23
23
23

Singapore |

Singapore

CITY

Population:
4.425.720
Area (km2) :
693

Map
Institution:
—
System:
—
Year:
—
Source:
—
Modes Number:
1
Modes:
Metro-Rail

Doc. Properties
Format (cm):
127.620 x 86.985
Software:
Adobe Photoshop7.0
Designer/Author:
—

DESIGN LEVELS

Structural Level | Graphic Level | Typographic Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Stop/Station:
Interchange:
Ring,Rings Connected
Landmarks:
—
Directionality:
—

Nº Line's Colors:
4 colors
Streets/Ave.:
—
Background Area:
—
Geographic References:
—

Fonts:
—
Station Orientation:
0º
Route Labelling:
—

Route Orientation:
—
Terminus:

St. Petersburg | Metro Map

Russia

CITY

Population:
4.577.751
Area (km2) :
606

MAP
Institution:
——
System:
——
Year:
——
Source:
www.saint-petersburg.com/transport/metro/map.asp
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES
Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/90º

Graphic Level

Stop/Station:

Interchange:
Pie
Landmarks:
——
Directionality:
——

Nº Line's Colors:
4 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Stockolm |

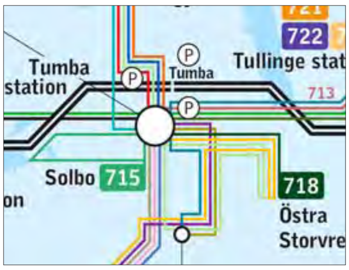
Sweeden

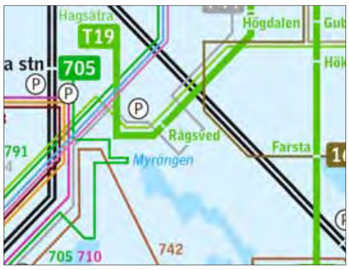
CITY

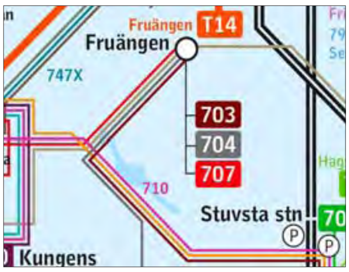
Population:
788.269
Area (km2) :
188

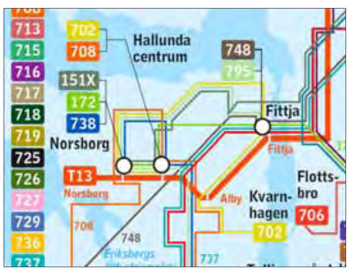
MAP
Institution:
BusvHuBo
System:
——
Year:
——
Source:
www.sl.se
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES
Format (cm):
18.598 x 15.844
Software:
Adobe Illustrator CS2
Designer/Author:
——









DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:
——
Interchange:
Ring
Landmarks:
——
Directionality:
——

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water + North

Typographic Level

Fonts:
SLGothicTimetable/Myriad-Roman
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Stockolm | Sweeden

CITY

Population:
788.269
Area (km2) :
188

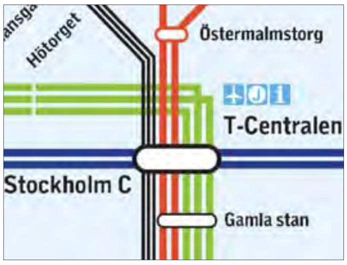
MAP

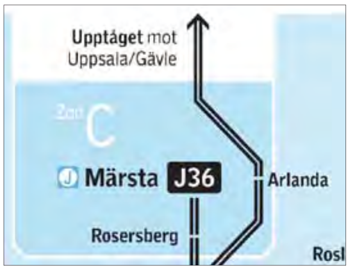
Institution:
SL Spartrafik
System:
——
Year:
2007
Source:

Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
77.791 x 57.593
Software:
Adobe Illustrator CS2
Designer/Author:
——





DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:
Interchange:
Rings Stressed
Landmarks:
——
Directionality:
——

Nº Line's Colors:
5 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
——

Typographic Level

Fonts:
SLGothic
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:
23
23

Stuttgart | Verbund - Schienennetz Portugal

CITY

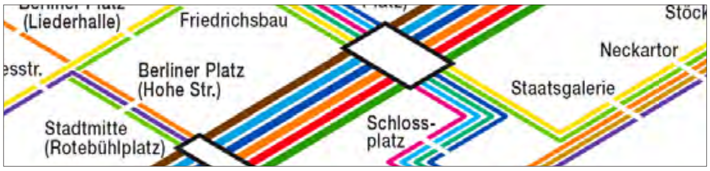
Population:
597.158
Area (km2) :
207

MAP

Institution:
VVS
System:
Verbund - Schienennetz
Year:
2007
Source:
www.vvs.de
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
42.011 x 29.700
Software:
FreeHand MX
Designer/Author:
Ingo Profuß



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
30º

Graphic Level

Stop/Station:
Interchange:
Blank Space
Landmarks:
Thematic Pictograms
Directionality:
——

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
——
Geographic References:
——

Typographic Level

Fonts:
Helvetica/ Univers
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Stuttgart | SBahnen — Germany

CITY

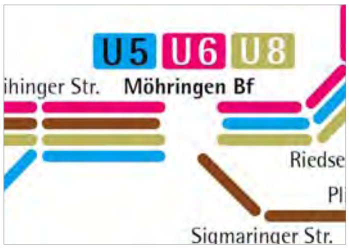
Population:
597.158
Area (km2) :
207

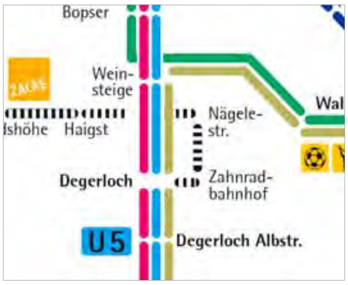
MAP

Institution:
S-Bahnen
System:
Stadbahnen
Year:
2007
Source:
www.vvs.de
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
44.518 x 30.013
Software:
Adobe InDesign CS2
Designer/Author:
——





DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:
Interchange:
Blank Space
Landmarks:
Thematic Pictograms
Directionality:
——

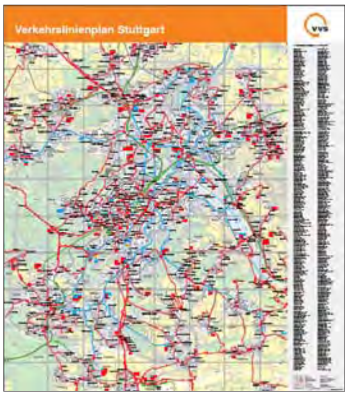
Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
——
Geographic References:
——

Typographic Level

Fonts:
AgfaRotisSemisans/ Helvetica
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
0º
Terminus:

Stuttgart | Verkehrslinienplan — Germany



CITY

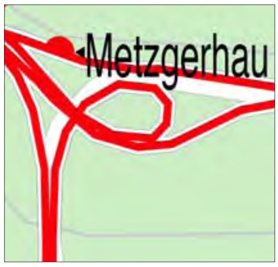
Population:
597.158
Area (km2) :
207

MAP

Institution:
——
System:
Verkehrslinienplan
Year:
2007
Source:
www.vvs.de
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
77.179 x 84.234
Software:
MapServer
Designer/Author:
Mentz Datenverarbeitung GmbH



DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:
Interchange:
——
Landmarks:
Thematic Pictograms
Directionality:
——

Nº Line's Colors:
3 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

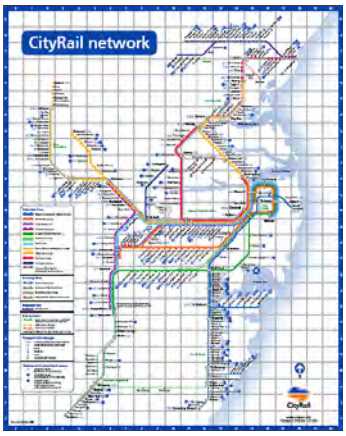
Typographic Level

Fonts:
Helvetica
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
Free
Terminus:
23

Sydney | CityRail Network

Australia



CITY

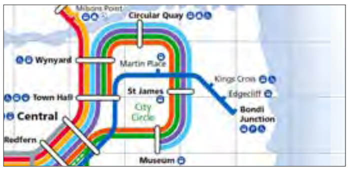
Population:
4.254.900
Area (km2) :
12145

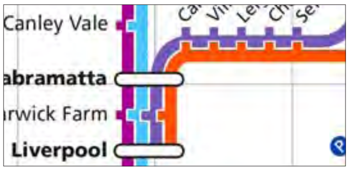
MAP

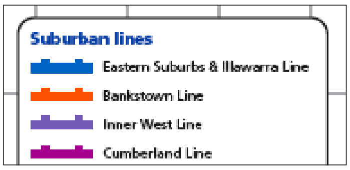
Institution:
CityRail
System:
——
Year:
——
Source:
www.cityrail.nsw.gov.au
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.697 x 41.995
Software:
QuarkXPress
Designer/Author:
——







DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
——
Directionality:
——

Nº Line's Colors:
12 colors
Streets/Ave.:
——
Background Area:
——
Geographic References:
Water + North

Typographic Level

Fonts:
Frutiger/Helvetica
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Taipei | Metro Sistem Map

Taiwan

CITY

Population:
2.630.872
Area (km2) :
272

MAP

Institution:
Metro /Department of Trans-portation
System:
——
Year:
——
Source:
www.trtc.com.tw
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
——
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
——
Directionality:
——

Nº Line's Colors:
6 colors
Streets/Ave.:
——
Background Area:
——
Geographic References:
——

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Taipei | Taiwan

CITY

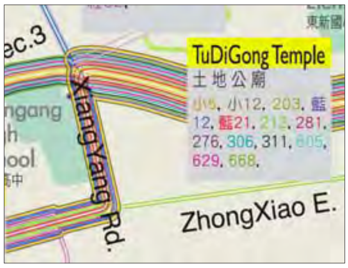
Population:
2.630.872
Area (km2) :
272

MAP

Institution:
Bus Routes Map
System:
—
Year:
—
Source:
www.trtc.com.tw
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
61.493 x 84.490
Software:
Adobe Illustrator
Designer/Author:
—



DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstractness:
Cartographic
Fixed Angles:
—

Graphic Level

Stop/Station:
—
Interchange:
—
Landmarks:
Pictograms
Directionality:
—

Nº Line's Colors:
15 or More
Streets/Ave.:
—
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
Arial
Station Orientation:
—
Route Labelling:
23

Route Orientation:
0º
Terminus:

Taipei | Taiwan

CITY

Population:
2.630.872
Area (km2) :
272

MAP

Institution:
Downtown
System:
—
Year:
—
Source:
www.trtc.com.tw
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
84.990 x 61.993
Software:
Adobe Illustrator
Designer/Author:
—

DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstractness:
Simplified
Fixed Angles:
—

Graphic Level

Stop/Station:
—
Interchange:
—
Landmarks:
Pictograms
Directionality:
—

Nº Line's Colors:
4 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land + North

Typographic Level

Fonts:
—
Station Orientation:
—
Route Labelling:
23

Route Orientation:
0º
Terminus:
Other

Tehran | Bus

Iran

CITY

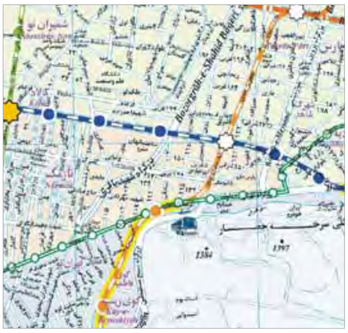
Population:
7.185.831
Area (km2) :
717

MAP

Institution:
Metro
System:
——
Year:
——
Source:
www.tehranmetro.com
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
84.657 x 66.202
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:
Interchange:
Pictogram
Landmarks:
Illustration
Directionality:
——

Nº Line's Colors:
10 colors
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Tel Aviv | Bus

Israel

CITY

Population:
390.100
Area (km2) :
51

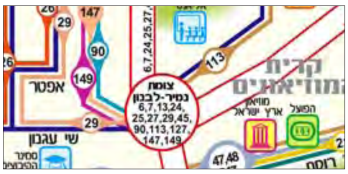
MAP

Institution:
——
System:
——
Year:
——
Source:

MODES NUMBER:
1
Modes:
Bus

Doc. Properties

Format (cm):
44.480 x 44.480
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:
——
Interchange:
Ring
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
——
Route Labelling:

Route Orientation:
Free
Terminus:
——

Tokyo | Metro Network

Japan

CITY

Population:
12.790.000
Area (km2) :
2187

MAP

Institution:
Metro
System:
——
Year:
——
Source:
www.tokyometro.jp
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.698 x 20.995
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/30º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Regular Polygon
Landmarks:
——
Directionality:
——

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Tokio | Metro Network

Japan

CITY

Population:
12.790.000
Area (km2) :
2187

MAP

Institution:
Metro
System:
——
Year:
2007
Source:
www.tokyometro.jp
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.698 x 20.996
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/30º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Iregular Polygon
Landmarks:
——
Directionality:
——

Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Torino | Italy

CITY

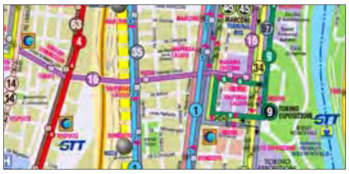
Population:
905.209
Area (km2) :
130

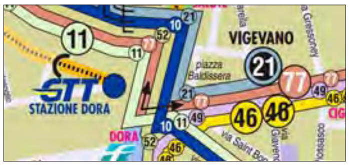
MAP

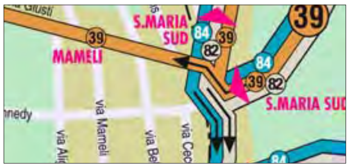
Institution:
GTT
System:
——
Year:
——
Source:
www.comune.torino.it/gtt
Modes Number:
1
Modes:
Bus

DOC. PROPERTIES

Format (cm):
97.069 x 137.563
Software:
——
Designer/Author:
u997







DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:
——
Interchange:
——
Landmarks:
Pictograms
Directionality:

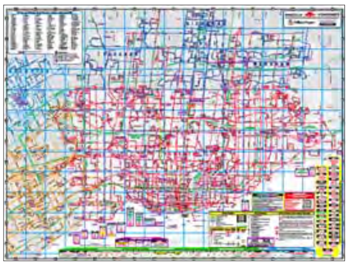
Nº Line's Colors:
15 or More
Streets/Ave.:
Street Map
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Gen.Swis721
Station Orientation:
——
Route Labelling:

Route Orientation:
0º
Terminus:

Toronto | Canada



CITY

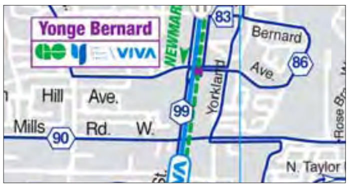
Population:
2.503.281
Area (km2) :
630

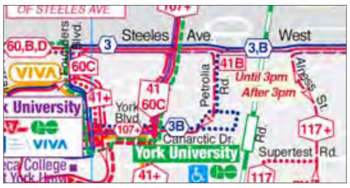
MAP

Institution:
TTC
System:
——
Year:
——
Source:
www.toronto.ca/ttc/
Modes Number:
2
Modes:
Metro-Rail/Bus

DOC. PROPERTIES

Format (cm):
69.207 X 50.159
Software:
Adobe InDesign CS (5.01)
Designer/Author:
Ian Dunlop





DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
Generic Point
Directionality:

Nº Line's Colors:
6 colors
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
——

Typographic Level

Fonts:
Arial/Gen.86/Helvetica/
MyriadPro
Station Orientation:
0º
Route Labelling:
Other

Route Orientation:
0º
Terminus:
——

Toulouse | System Map France

CITY

City:
Toulouse
Population:
426.700
Area (km2) :
35

MAP

Institution:
Tisseo
System:
——
Year:
——
Source:
www.tisseo.fr
Modes Number:
1
Modes:
Metro-Rail/Bus/Tram

DOC. PROPERTIES

Format (cm):
105.821 x 105.821
Software:
——
Designer/Author:

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
15 or More
Streets/Ave.:
Highways & Avenues
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
23
23

Route Orientation:
Free
Terminus:

Valencia | Metro Valencia Spain

CITY

Population:
807.200
Area (km2) :
135

MAP

Institution:
MetroValencia
System:
Plano Zonal
Year:
——
Source:
——
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.700 x 42.011
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstratcness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
——
Directionality:
——

Nº Line's Colors:
5 colors
Streets/Ave.:
——
Background Area:
Tariff & System Zones
Geographic References:
——

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Valencia | Metro Valencia   Spain

CITY

Population:
807.200
Area (km2) :
135

MAP

Institution:
MetroValencia
System:
Plano de la xarxa
Year:
——
Source:
——
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.700 x 42.011
Software:
——
Designer/Author:
——

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
Pictograms
Directionality:
——

Nº Line's Colors:
6 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
——
Station Orientation:
0º
Route Labelling:
——

Route Orientation:
——
Terminus:

Vancouver | Canada

CITY

Population:
611.869
Area (km2) :
115

MAP

Institution:
TransLink
System:
——
Year:
——
Source:

Modes Number:
3
Modes:
Metro-Rail/Bus/Boat

DOC. PROPERTIES

Format (cm):
32.133 x 24.155
Software:
FreeHand MX
Designer/Author:
Lester Jones

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Cartographic
Fixed Angles:
——

Graphic Level

Stop/Station:

Interchange:
Ring
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
5 colors
Streets/Ave.:
Highways & Avenues
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Frutiger
Station Orientation:
0º
Route Labelling:
23

Route Orientation:
Free
Terminus:

Venezia | Hellovenezia

Italy

CITY

Population:
268.934
Area (km2) :
412

MAP

Institution:
Actv
System:
Hellovenezia
Year:
——

Source:
www.actv.it
Modes Number:
1
Modes:
Boat

DOC. PROPERTIES

Format (cm):
29.697 x 20.998
Software:
——

Designer/Author:
mpasqualotto

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

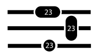
Graphic Level

Stop/Station:
Other
Interchange:
Rings Stressed
Landmarks:
Illustration
Directionality:
Other

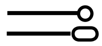
Nº Line's Colors:
15 or More
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Land

Typographic Level

Fonts:
——
Station Orientation:
Fixed Angles
Route Labelling:



Route Orientation:
Fixed Angles
Terminus:



Vienna | Der Plan Der Schnelisten Wege

Austria

CITY

Population:
1.670.347
Area (km2) :
415

MAP

Institution:
Wienerlinien
System:
——

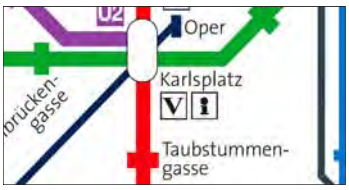
Year:
——

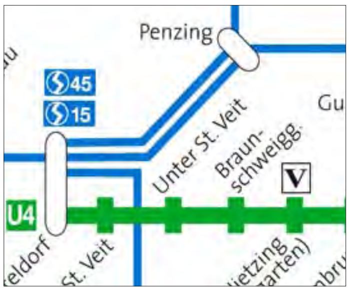
Source:
www.wienerlinien.co.at
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
29.697 x 20.998
Software:
——

Designer/Author:
——





DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Stressed
Landmarks:
——
Directionality:
——

Nº Line's Colors:
6 colors
Streets/Ave.:
——
Background Area:
Geographic References
Geographic References:
Water

Typographic Level

Fonts:
Courier/ Helvetica/ The Sans
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Washington D.C. | Metro Sistem Map

USA

CITY

Population:
582.049
Area (km2) :
177

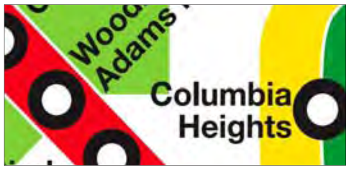
MAP

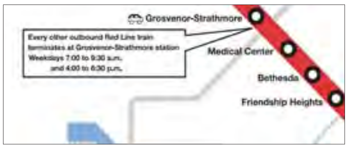
Institution:
Metro (WMATA)
System:
System Map
Year:
2006
Source:

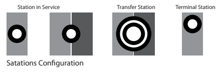
Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
21.587 x 27.937
Software:
——
Designer/Author:
——







DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Concentric Rings
Landmarks:
Illustration
Directionality:
——

Nº Line's Colors:
5 colors
Streets/Ave.:
Highways & Avenues
Background Area:
Geographic References
Geographic References:
Water & Land + North

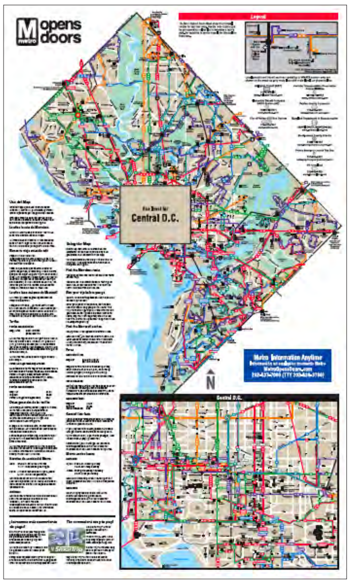
Typographic Level

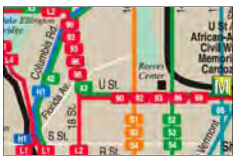
Fonts:
Helvetica
Station Orientation:
Fixed Angles
Route Labelling:
——

Route Orientation:
——
Terminus:

Washington D.C. | Metro Open Doors

USA





CITY

Population:
582.049
Area (km2) :
177

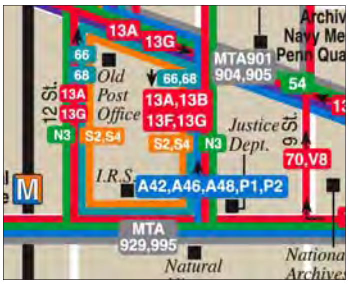
MAP

Institution:
Metro (WMATA)
System:
System Map
Year:
2006
Source:

Modes Number:
1
Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
21.587 x 27.937
Software:
——
Designer/Author:
——



DESIGN LEVELS

Structural Level

Style:
Classic
Fidelity/Abstractness:
Simplified
Fixed Angles:
——

Graphic Level

Stop/Station:
——
Interchange:
——
Landmarks:
Generic Point/ illustration
Directionality:

Nº Line's Colors:
7 colors
Streets/Ave.:
Main Streets
Background Area:
Geographic References
Geographic References:
Water & Land

Typographic Level

Fonts:
Helvetica
Station Orientation:
——
Route Labelling:

Route Orientation:
0º
Terminus:

Zurich | Stadt Zurich

Switzerland

CITY

Population:
376.815
Area (km2) :
92

MAP

Institution:
ZVV
System:
Stadt Zurich
Year:
2008
Source:
www.zvv.ch
Modes Number:
3
Modes:
Metro-Rail/Bus/Boat

DOC. PROPERTIES

Format (cm):
29.697 x 41.497
Software:
FreeHand MX
Designer/Author:
H+A Eggman

DESIGN LEVELS

Structural Level

Style:
Combination
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:

Directionality:

Nº Line's Colors:
11 colors
Streets/Ave.:

Background Area:
Geographic References
Geographic References:
Water

Typographic Level

Fonts:
Meta
Station Orientation:
Fixed Angles
Route Labelling:
23

Route Orientation:
Fixed Angles
Terminus:
Other

Zurich | S-Bahn

Switzerland

CITY

Population:
376.815
Area (km2) :
92

MAP

Institution:
ZVV
System:
S-Bahn
Year:
2007
Source:
www.zvv.ch
Modes Number:

Modes:
Metro-Rail

DOC. PROPERTIES

Format (cm):
10.499 x 14,798
Software:
QuarkXPress
Designer/Author:
Rahel Gasper

DESIGN LEVELS

Structural Level

Style:
French
Fidelity/Abstractness:
Schematic
Fixed Angles:
0º/45º/90º

Graphic Level

Stop/Station:

Interchange:
Rings Connected
Landmarks:
Pictograms
Directionality:

Nº Line's Colors:
12 colors
Streets/Ave.:

Background Area:
Politic
Geographic References:
Water

Typographic Level

Fonts:
Meta
Station Orientation:
Fixed Angles
Route Labelling:
23
23
23

Route Orientation:
0º
Terminus: